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AN ECONOMIC AND INSTITUTIONAL ANALYSIS OF SOIL EROSION ON AGRICULTURAL LAND

by

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DEDICATED TO THE MEMORY OF MY PARENTS

Abstract

This study is concerned with socioeconomic and environmental consequences and policy implications of the soil erosion problem within several categories of interdependencies and human interactions with respect to soil resource use. The development and selection of potential alternative farm level soil erosion control policies and organizational structure for soil erosion control, with special reference to the Peace River region of Alberta, is emphasized.

Loss of productive agricultural soils from water induced erosion in the Peace River region is attributed to soil characteristics, farming practices, farmers' perception of current soil uses in a private landownership and existing soil erosion control policies. The farm level soil loss results in temporal and spatial damages because the soil has both qualitative and quantitative characteristics.

Existing policies and programs available to farm operators and government agencies generally ignore farm level soil erosion problems which are closely related to farming practices and farmers' perceptions of soil use. Courses of action available currently are often unable to facilitate correction of external soil erosion effects for which they were formulated. A lack of coordination between government agencies and poor communication with farm operators is observed. This deficiency results in aggravated confusion and a high frequency of inaction regarding soil erosion control.

To bring some degree of correspondence among actions of farm operators, government agencies and the interests of society, an institutional approach, which is a creative synthesis of Commons' (1924, 1934a) institutional-mainstream economics (structure-conduct-performance model), is utilized in this study. This approach emphasizes the need for an identification of alternative institutional arrangements to alter behaviour and, consequently, improve performance (reduce soil loss).

Effects of soil erosion on soil characteristics are analyzed using Lancaster's "goods and characteristics approach" (Lancaster, 1966a, 1966b). In order to examine farmers' behaviour and its effects on soil characteristics, Lancaster's approach is combined with an institutional approach. This synthesis results in a soil characteristics-farmer behaviour model. This model provides both qualitative and quantitative analysis of the soil resources which are necessary for soil erosion control policies and indicates that soil characteristics can be improved over time slowly through proper incentives and technical assistance.

Results of a farmers' attitude survey indicate that a majority of the farm operators perceive the problem as serious and that sheet and rill erosion are of particular concern to a large proportion of farmers. In farmers' views, current soil erosion control policies are ineffective, expensive and time-consuming and do not directly deal with the farm level problem as is evident from the survey results. Most proposed policies are perceived by farmers and extension workers as "fair". However, farmers favoured mutual or voluntary means of implementation.

Five policies, education, research, cost-sharing development, implementation of an approved soil erosion control plan and revision of the Soil Conservation Act are proposed to induce changes in farm operators' behaviour (conduct) so as to achieve desired performance (less soil loss). A well defined organizational setup which can integrate administrative, financial and research activities is proposed to obtain full potentialities of the proposed policies. The potential performance of the policies is assessed using efficiency, equity and capability criteria. In general, the proposed policies are consistently equitable, effective and capable regarding various groups in society, although assessment is based on subjective value judgements.

This study has two important policy implications. First is the theoretical significance of the developed approach. The creative synthesis of Commons' institutional-mainstream economics utilized in this research provides an alternative formulation to deal with natural resource use problems. Second, the approach used in this study suggests possibilities for analyzing these problems. The suggested approach provides, in many ways, a broader description of

such problems to policy-makers and provides increased capability for assessing the performance of public policy.

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This thesis is dedicated to my parents, who unfortunately passed away during my stay in Canada. They left these words for me: *"Light and darkness are considered to be the two eternal paths of the world. By following the first, one reaches the Supreme State, not to return; by* *following the other, he returns to the mortal world"*

(Bagavad Gita, Ch. 8-26).

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I. Introduction

Soil is an essential component of the ecosystem and an essential natural resource for the continuing development and maintenance of a viable agricultural industry. Loss of productive soil may have serious agricultural, socioeconomic and environmental consequences for a region or country in the form of a less certain future arising from these irreversible soil losses. These pending irreversibilities have very recently prompted agricultural researchers in Canada to focus on soil erosion on agricultural lands. Water induced erosion is recognized in every province (Agricultural Institute of Canada, 1980).

Water induced soil erosion has been identified as a serious problem in the Peace River region of Alberta. Furthermore, it is directly related to the current farming practices and farm operators' perceptions (Phillips, DePape and Brook 1975; Environment Conservation Authority 1976). Growing recognition of the conflict between increasing demand for food production and soil loss prompts the suspicion that traditional notions of landownership and uses may not be adequate to meet current challenges. Freedom, historically attached to the private ownership of land, seems to come more and more at the expense of social good in a highly mechanized and capital intensive farming industry.

This research is concerned with the socioeconomic consequences of farm level water induced soil erosion problems, with particular reference to the Peace River region of Alberta. This introductory chapter briefly summarizes the nature and scope of the problem, outlines the research objectives of the study, summarizes the approaches used and provides the format of the study.

A. Nature and Scope of the Problem

One of the greatest problems facing the world in the near future is the fulfilment of a growing demand for food and fiber by a continuously increasing global population without irreversibly damaging the productive soil base upon which man's very survival depends. The basic needs of six billion persons by the year 2000 will require at least a twofold increase in food production (National Academy of Science 1971; United Nations 1974). This production increase on current land resources will require a threefold increase in energy for agriculture within this short time span (Pimental et. al. 1974 and 1976). Expanded food production can be met by increasing intensive and extensive margins of agricultural land uses. This avenue holds little promise, however, in countries where most cultivatable land has already been brought under intensive cultivation (Mishra and Marothia 1975). Increasing land resource scarcity suggests improved soil resource management if the global food production capability is to improve.

Soil is an essential component of food production, yet productive soil is being lost continuously throughout the world (Biswas and Biswas 1978). A large portion of this loss is through water induced soil erosion, the seriousness of which will intensify as global food demands increase. Since there appears to be no international soil erosion protection agency forthcoming, the socioeconomic and environmental consequences of soil degradation will have to be dealt with domestically and should be given priority regionally and nationally.

Canada currently exports approximately 10 percent of its agricultural production. Increasing export demand for Canadian agricultural commodities, notably grain, will put increasing pressure on expanded intensive and extensive margins of Canadian agricultural land use which is accentuated even more by competing land uses, such as urbanization and transportation.[1] There is already a growing concern in Canada over accelerated soil deterioration from various causes, including water induced soil erosion.

One of the most notable regions in Canada experiencing pronounced soil erosion is the Peace River region in Alberta. Current farming practices include crop residue removal, extensive summerfallowing and improper crop rotations which facilitate significant soil losses through water induced erosion. Unique soil characteristics (shallow layer of topsoil and low organic matter), long gentle slopes, intensive summer rainfall and rapid spring snowthaw, are all contributing factors to soil loss in this area.

---

[1] For a balanced view on land use issues, see Veeman (1981). Also see Manning (1969, 1975), Phillips and Schultz (1971) for potentiality of agricultural resources and guidelines for their use. See also "Farmland: Canada's Threatened Natural Resource," *Agrologist* 4 (Autumn) 1975; and *Prairie Production Symposium*, sponsored by the Advisory Committee to the Canadian Wheat Board (October) 1980.

Use of current soil erosive practices is directly related to farm owners' perceptions of soil resource use. Many Peace River farmers incur soil losses which result in higher farm operating costs, but which tend to be ignored since the soil losses (and hence costs) take place through the process of aggregation and over space and time. This imposition of costs arises because the erosion process affects both qualitative and quantitative characteristics of soil resources. Thus from a purely economic point of view, soil erosion represents a permanent reduction of rent in the case of topsoil (quantitative) loss and a significant reduction of rent in the case of fertility depletion (qualitative) within reversible limits. Many farmers make no allowance for the depreciation of land values resulting from soil loss in their net returns calculations. Furthermore, farmers are often not aware of the fact that soil erosion is reducing the value of the soil resource, particularly if it is confined to sheet and rill erosion. They treat net income as if it were net returns and make no allowance for the loss in value of land. As a result, use of erosive practices inflicts lower private costs and tends to be reflected in higher net returns than would result under soil erosion control practices, and these returns may become capitalized with excessively high land values (Bunce 1942, pp. 14-20).

To be economic to the individual farmer, soil erosive practices yield annual net returns for the current year in amounts greater than would be realized under soil erosion control practices. Moreover, as price responsive individuals, farmers may be applying more fertilizer to compensate for soil loss in situations in which prices of agricultural commodities rise or costs of production fall. Thus, the difference between returns from land resources under soil erosive and under soil erosion control practices varies with changes in techniques of production, changes in the magnitude of market signals (competitive prices of products and inputs and prevailing interest rates). For an individual farm operator, individual time preference and foresight are also determining factors (Ciriacy-Wantrup 1938a, 1938b and 1939).

In the case of land values, market prices are inadequate as they tend to reflect more immediate factors thus contributing to land value assessments which are a long way from the normal values. Moreover, in many cases, prices and interest rates are not fully competitive and do not accurately reflect future expectations even where these are known (Bunce 1943, pp. 99-100; Hicks 1938, p. 226). The market signals fail to incorporate the real causes of soil losses which are the following: dominance of traditional soil erosive farming practices; resistance to changes in current farming practices and major institutional arrangements; lack of knowledge and desire for individual adjustment; and lack of incentives. Retention of uneconomic soil uses and static behaviour, coupled with private landownership, create conflicts and disorder among farm operators, among farm operators and non-farm operators, and between present and future generations.

Failure of the individual farm operator to maintain soil productivity at the point where soil erosion control measures become economic leads to a permanent social loss. Society is justified in initiating action to prevent it. In the case of uneconomic soil resource use in which both topsoil and fertility loss take place, both the reduction of present net returns and future net returns occur and where irreversible soil resource destruction takes place, society is justified in making investments to prevent such permanent soil loss. Where soil loss is uneconomic to the farm operator and also results in other social losses, the case for social action is strengthened (Bunce 1940, pp. 48-99). These situations are particularly apparent in the Peace River region where society's investment in soil resources is needed to bring about some degree of correspondence between the actions of farm operators and the interest of society.

Existing government soil erosion control policies and programs are correction rather than prevention oriented, time-consuming, ineffective, expensive and unable to alter farm operators' behaviour to mitigate erosion. Also the current institutional arrangements pertain largely to correction of external effects and completely ignore the farm level problems which are closely associated with farming practices and farmers' behaviour. Furthermore, the existing institutional arrangements do not even include a wide ranging opportunity set to induce altered farm operators' behaviour related to the secondary erosion problem (external effects in water diversion cases). The various agencies which are responsible for controlling soil erosion problems also lack coordination.

The central issue then becomes one of determining a set of institutional arrangements which influences individual farmer behaviour and shapes the structure of unorganized agencies involved in soil resource management. In other words, the central issues in this study are to identify a set of institutional arrangements that impose minimum cost on those whose current behaviour or action requires modification and to propose an analytical framework within which an individual's freedom, security and rights, as well as justice, can be expressed without inflicting harm on others. At this juncture, the farm level soil erosion problems in the Peace River region are of paramount significance.

B. Objectives

The main purpose of this research is to discuss and analyze the major socioeconomic and environmental consequences and policy implications of the soil erosion problem within the context of an interdependent network with respect to soil resource use.

The specific research objectives are:

1. to discuss the importance of economic behaviour and property rights in the context of natural resource policy;
2. to analyze the spatial, temporal, qualitative and quantitative dimensions of the farm level soil erosion problem;
3. to develop a theoretical formulation by combining institutional and neoclassical economics in a framework capable of addressing a complex resource problem such as soil erosion;
4. to develop a soil characteristics-farmer behaviour model to analyze qualitative and quantitative characteristics of soil resources;
5. to analyze the perceived acceptability of alternative soil erosion control policies by farmers and extension workers;
6. to evaluate existing soil erosion control policies and programs that are influenced by current institutional arrangements, and to explore alternative institutional arrangements and corresponding policies and programs designed to enhance erosion control at the farm level;
7. to set forth efficiency, equity and capability criteria to evaluate alternative farm erosion mitigation policies and programs; and
8. to summarize the major conclusions and policy recommendations of the study with respect to soil erosion

control policies in the Peace River region, and to indicate the probable implications of the study for similar resource problems.

C. Approaches Used in the Study

The study utilizes and combines various concepts and approaches of neoclassical and institutional economics. A novel synthesis using Commons' (1924, 1934a) institutionalism and neoclassical economics (a structure-conduct-behaviour model) is used in this research to provide an analytical framework. The purpose of this synthesis is to derive an improved theoretical formulation and to attain a better understanding and conceptualization of the social categories of interdependencies and human interactions with respect to soil resource use. The purpose here is to supplement the neoclassical framework rather than replace it with institutional economics. Major research related to the soil erosion problem utilizes the optimization framework to analyze soil erosion problems and policies. These models do not work in the analysis of farm operators' behaviour and person-to-person relationships with respect to soil resource uses. The suggested approach provides a superior analytical framework to deal with soil erosion problems.

Current soil erosion programs are being shaped around estimates of soil loss, measured in tonnes per hectare per year (use of the universal soil loss equation; Wischmeier and Smith 1965). This measure yields only estimates of quantitative soil resource losses. Evaluation should also yield qualitative information necessary for soil erosion control. A soil characteristic approach in relation to farmer behaviour, using Lancaster's (1966a, 1966b) "goods and characteristics approach" is used in this study. It considers better qualitative and quantitative characteristics of soil resources.

In order to select the most effective and appropriate farm level soil erosion control policies, a farmer attitude survey has been conducted. Perceived acceptability of alternative soil erosion control policies by farmers and extension workers has been analyzed. The approach developed in this study (Commons' mainstream synthesis) is used to analyze current institutional arrangements, formulate and select policies and evaluate potential soil erosion policies. Efficiency, equity and capability criteria are suggested with refined theoretical formulations to assess the potential performance of the suggested policies.

D. Format

The study is presented in the following format. Chapter II briefly describes the general and agricultural characteristics of the Peace River region. Chapter III discusses the foundation of logical inferences in resource policy. This chapter serves as a preface to the analytical approach. In Chapter IV, the analytical framework is presented. It provides the analytical framework relating to soil resource use, private landownership issues, soil erosion process, soil characteristics-farmer behaviour model and farmers' attitude survey. Chapter V outlines the institutional approach which is a synthesis of Commons' institutionalism and mainstream economics. This chapter provides a brief statement on the intellectual roots of the institutional approach followed by Commons' determinants of policy analysis and Commons' schema of authorized, authoritative and authority relationships. In this chapter, a conceptual framework is also developed using Commons' mainstream economics synthesis to analyze soil erosion control policies. Chapter VI analyzes the qualitative and quantitative soil characteristics within Lancaster's "goods and characteristics approach" (Lancaster, 1966a, 1966b) and is supplemented with institutional arrangements. In Chapter VII empirical results of the farmers' attitude survey are presented. Results provide the farmers' responses to current policies and to the perceived fairness of proposed policies. Extension workers' responses to current and proposed policies are also analyzed. In Chapter VIII, an institutional approach is used to examine current soil erosion policies and existing administrative organization. Alternative soil erosion control policies are proposed and evaluated using efficiency, equity and capability criteria. Summary, conclusions and implications are presented in Chapter IX.

II. Description of the Study Area

The area under study is referred to as the Peace River region of Alberta. Section A of this chapter briefly describes the general characteristics of the study area. Section B deals with the agricultural characteristics of the study area.[2] Emphasis is selectively placed on those characteristics which are closely related to the soil erosion problem.

A. General Characteristics

Location: Most of the Peace River block lies in the Province of Alberta (Figure II.1), with part of the block extending into British Columbia. The study area is confined, however, to the jurisdictional boundaries of the Peace River Regional Planning Commission in Alberta (Figure II.1). The Planning Commission region (study region) is slightly smaller than Census Division 15.[3] The Peace River region is located in the northwest corner of Alberta, extending northward from approximately the fifteenth base line to the boundary of the Northwest Territories. The region's east-west extent is from the British Columbia border to approximately the fifth meridian. The region lies between 55 and 60 degrees north latitude and 120 and 116 degrees west longtitude. The total area of the region is 216,000 square km which constitutes approximately one-third of the total area of the province, whereas the total area of Census Division 15 is approximately 240,117 square km, which occupies about 34 percent of the area of the Province (Peace River Regional Planning Commission, 1973).

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[2] Since details relating to the physical, demographic, economic, agricultural, and other characteristics are reported in the various publications of the Peace River Regional Planning Commission, a brief description of the study area herein is sufficient.

[3] All the statistical figures reported in this chapter are related to Census Division 15 (CD 15).

Climate: The climate of the Peace River region is well suited to the production of various agricultural crops. In the Peace River region, annual precipitation averages 482 mm with 303 mm. occurring during the growing season (May to September). June and July are the months with the most intensive rainfall. The average rainfall in a 24-hour period is an indication of intensity. For June and July, the intensity ranges from 48 mm to 101 mm. The growing degree days (May to September) amounts to about 1,200. Generally, there are between 77 and 109 frost-free days each year and the frost period extends roughly from June to August. The length of the frost-free periods varies considerably throughout the region due to topography, altitude, vegetation and large water bodies in the region. The annual mean temperature is 0.5 degrees C. This low figure is due to the long cold winters, but short warm summers. The average mean temperature for the month of July is 16 degrees C, while that for Januray is 19.4 degrees C. Normal snowfall (October to April) in the region is 155 cm (Atmospheric Environment Services 1975). The most serious soil erosion takes place during rapid spring melt and during intense summer rainfall.

Demography and Economy: Population of the region (CD 15) stood at 106,993 during 1976, of which 58,140 were categorized as rural and 48,850 as urban. The overall population density of 1.2 persons per square km belies the concentration of population in the agriculturally settled areas. In 1976, the region had 5.82 percent of the province's population. Between 1971 and 1976, the population of the region increased by 10.50 percent due to vital rates and net migration effects (Peace River Regional Planning Commission, 1980).

The region's economy is based on agriculture and natural resources (petroleum, natural gas and forestry) development. Agriculture commands nearly 23 percent of the total labour force and remains the leading employment sector among the basic industies. Mines, quarries and oil wells industries accomodate 5.6 percent of the labour force, while forestry and fishing and trapping industries represent 2.5 percent (Statistics Canada, 1976 and Peace River Regional Planning Commission, 1978).

Highly mechanized farming, increasing natural resource extraction, extensive land clearing for agricultural purposes and growing secondary or manufacturing industries characterized the regional economy through the 1970s. As a result of the rapid expansion in all of these activities, the general infrastructure of the region has increased significantly over the last two decades.[4] All these expanding activities, coupled with increases in population and the labour force in the primary as well as secondary industries, no longer support the notion of the region as a frontier settlement.[5]

B. Agricultural Characteristics

Agriculture has been a major economic activity in the Peace River region since the early 1900s. Historically this region has served to accommodate a large influx of agricultural settlers during the 1920s and 1930s and after World War II. Over the years as agricultural activities advanced and mechanization increased, extensive tracts of virgin land were broken and cleared. Exploration and development of petroleum and natural gas quickened the pace during the 1960s and 1970s. Over the years, as economic activities increased and the general infrastructure, along with several secondary industries, developed, agriculture remained one of the most important basic industries in the region (Environment Conservation Authority 1976). Although the contribution of Peace River agriculture to agricultural products outside of the region is small, its contribution locally is more significant than mines, quarries and oil wells sectors in terms of generating local commercial activity through money circulation and total employment (Fairbairn and Ironside 1973). Keeping in view the major role of agriculture in the region, this section is now directed to a brief discussion of important aspects of Peace River agriculture.

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[4] For a detailed discussion on the Peace River region's development activities, see *Peace Country Agriculture*, Peace River Regional Planning Commission, August 1978.

[5] Many researchers still regard this region as a frontier settlement (a notion which was probably true in the 1960s). See, for example, Ironside and Fairbairn, (1977).

Land Use and Agricultural Production: The Peace River region covers over 25 million hectares of land of which 8 million hectares is potentially arable. This is about 70 percent of the total potential arable land in all of northwestern Canada (MacKenzie and Rice, 1976). Figure II.2 shows the potential agricultural areas in the region. About 10 percent of the 25 million hectares is farmland with approximately 1.58 million hectares improved farmland occupied by 8120 farm operators. Average farm size is about 306.5 hectares (Statistics Canada 1976).

Area, production and average yields of major crops are presented in Table II.1. The table shows a declining trend in the crop area and production for all crops except rapeseed over three years. The area under rapeseed increased more than threefold during 1976-1979. Summerfallow acreage increased in absolute terms. However, its proportion of the total cropped area has declined very slightly in 1979. It is important to note that summerfallowing still accounts for over 21 percent of the total cropped area in the Peace River

TABLE II.1

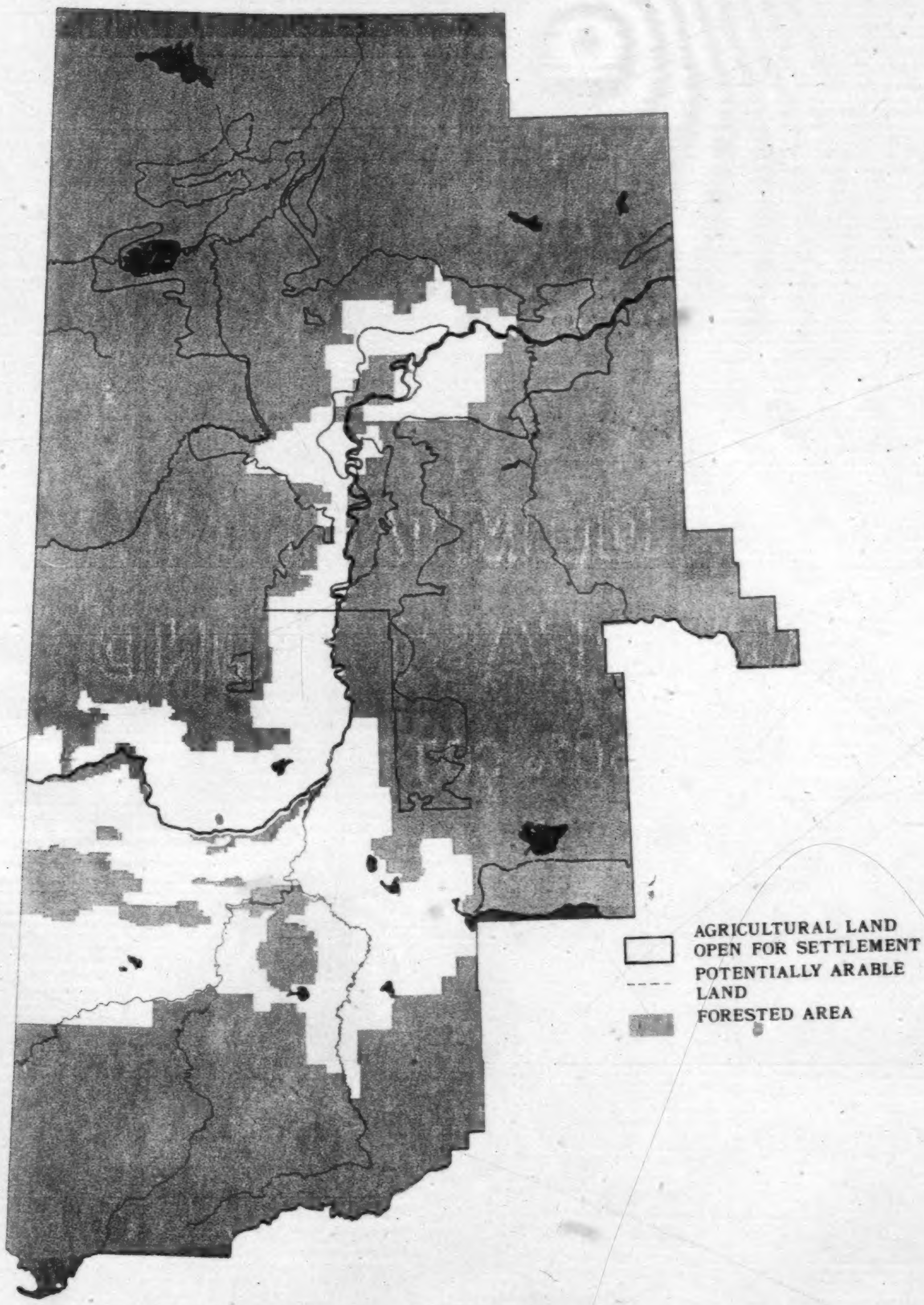
AREA, PRODUCTION AND YIELDS OF MAJOR CROPS IN THE PEACE RIVER REGION, 1976-1979

Crops	Area ('000 hectares)				Production ('000 tonnes)			Yield (tonnes) Per Hectare		
	1976	1979	Area Occupied as % of the Total Improved Area		1976	1979	% Change	1976	1979	% Change
			1976	1979						
Wheat	153	129	9.66	7.70	339	295	-12.97	2.2	2.3	4.54
Oats	66	36	4.17	2.15	135	84	-37.77	2.0	2.3	15.00
Barley	450	287	28.43	17.16	920	648	-29.56	2.0	2.3	15.00
Rapeseed	125	470	7.89	28.10	4,986	18,298	266.98	0.9	0.9	0.0
Hay*	236	214	14.90	12.79	1,081	942	-12.85	4.58	4.40	-4.00
Summerfallow	345	356	21.77	21.28	-	-	-	-	-	-
Improved Area	1,583	1,673	-	-	-	-	-	-	-	-
Total Farmland	2,488,060	2,540,420	-	-	-	-	-	-	-	-
Improved area as % of Total Farmland	64	65	-	-	-	-	-	-	-	-

*Acreage of Hay includes the area devoted to alfalfa.

SOURCES: Agricultural Statistics Yearbook, 1979. Alberta Agriculture
Census of Canada, 1976. Statistics Canada
Hanus, F. (1980), Table 3.

FIGURE II.2
DISPOSITION OF AGRICULTURAL LAND


AGRICULTURAL LAND OPEN FOR SETTLEMENT
POTENTIALLY ARABLE LAND
FORESTED AREA

Source: Preliminary Regional Plan, Peace River Regional Planning Commission.

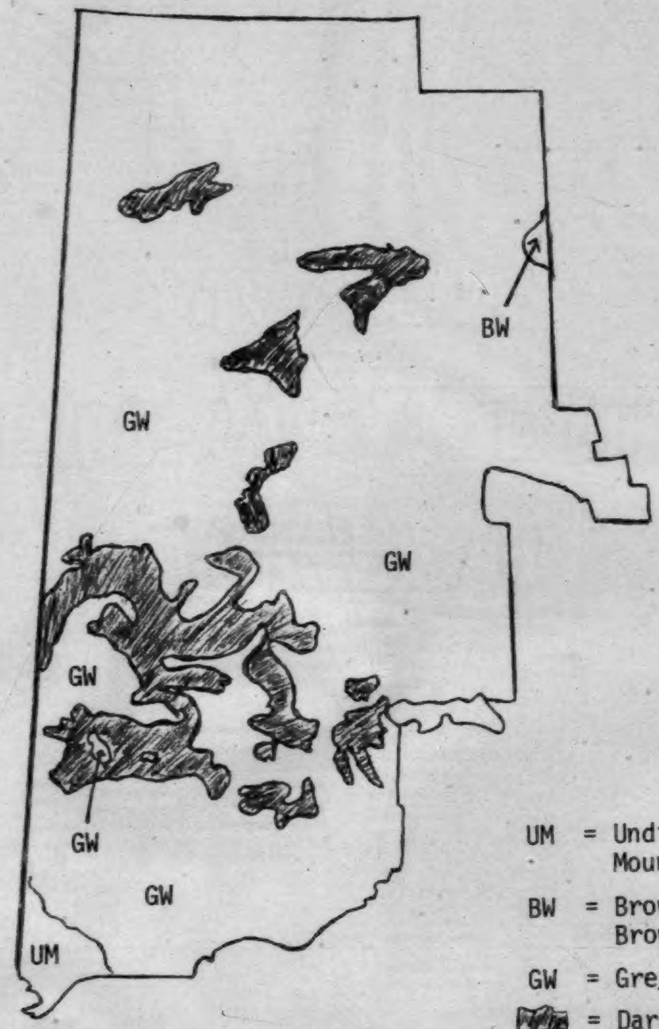
region. Rapeseed production, as well as summerfallowing elevate soil loss. The area under hay (and alfalfa) decreased during 1976-1979 which is a discouraging sign for soil erosion control. Yield rates remain almost constant for all crops.

In addition to crop production, livestock production has increased considerably in the region. Production of beef cattle, dairy cattle, swine and poultry, along with forage production, are of significant importance (Statistics Canada 1976).

Soils Capability: Many of the prime agricultural soils in the Peace area were formed on lacustrine silts and clay deposited in the glacial lakes that covered this area during the retreat of glaciers (Peace River Regional Planning Commission, 1976). The Peace River region soils are predominantly Dark Grey, Dark Grey Wooded (plains areas) and Grey Wooded (forest areas) soils (Figure II.3). The high clay content of these soils slows infiltration of moisture which can result in excessive runoff. Dark Grey and Dark Grey Wooded soils have a black to dark grey surface horizon that varies from 7.5 cm to 20 cm. These soils are quite productive and support a wide variety of crops in the region. On the other hand, Grey Wooded soils are characterized by a layer of leaf mat at the surface, followed by a fairly dark horizon of usually less than 5 cm which overlays a distinct grey leached plate structured

FIGURE II.3

SOILS OF THE PEACE RIVER REGION



UM = Undifferentiated Mountain Complex

BW = Brown Wooded and Acid Brown Wooded Soils

GW = Grey Wooded Soils

▨ = Dark Grey and Dark Grey Wooded Soils

SOURCE: Alberta Soil Surveys, Research Council of Alberta.

horizon. These soils are less productive, very low in organic matter and therefore require heavy fertilization. Only a very small portion of the Grey Wooded soils in the Peace River region is currently developed agriculturally. Thus, low organic matter and high clay content in many of the Peace River soils cause these soils to puddle and crust and restrict the infiltration of rainfall or spring snowmelt and render the soil highly susceptible to erosion.

According to a preliminary estimate of acreages by soil capability for agricultural purposes (Table II.2), there is no Class 1 soil in the Peace River region. Data presented in Table II.2 indicates that Classes 2 to 4 comprise about 47 percent of total arable potential (about 5.13 million hectares). Class 5 comprises about 25 percent of the total arable land (about 2.50 million hectares) in the region.

Farm Organization: Farm organization, landownership and farm tenure are the legal and contractual arrangements by which farm operators secure a bundle of absolute rights. However, in recognization of societal interests, government holds limitations on private landownership.[6] Table II.3 indicates the farm organization and landownership patterns in the Peace River region. In the region, most of the farm area is operated by private individuals (1,238,549 hectares), followed by part-owner and part-tenant areas

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[6] These concepts are discussed in more detail in later chapters.

TABLE II.2

SOIL CAPABILITY FOR AGRICULTURE CLASSES IN THE PEACE RIVER REGION OF ALBERTA

Class (CLI)*	Limitations	Area ('000 Hectares)	Percent of Total Area Surveyed
1	None	0	0
2	Moderate	791.96	7.2
3	Moderately Severe	1,575.82	14.3
4	Severe	2,760.73	25.0
5	Improved Pasture	2,750.61	24.9
6	Non-Improvable	315.65	2.8
7	Non-Agricultural	1,655.14	15.0
Organic	More than 12" Peat	1,195.83	10.8
Total Area Surveyed (Hectares)	27,295	11,045.74	100.00

*CLI = Canada Land Inventory

SOURCE: Alberta Agriculture, A Preliminary Estimate of the Acreages of the Soil Capability for Agriculture Classes in Alberta. Soils Branch, Edmonton: (February), pp. 11-13, 1974.

TABLE II.3

FARM ORGANIZATION AND LAND OWNERSHIP IN THE PEACE RIVER REGION, 1976

Farm Population	Total Number of Farms	Type of Organization (Number)						Land Ownership (Land Tenure)						Total Area Owned (Ha.)	Total Area Rented (Ha.)	Total Area of Farms (Ha.)
		Private Individual	Partnership	Institution or Community Pasture	Legally Constituted Company			Owner		Tenant		Part-Owner Part-Tenant				
					Family	Other	Other Type	No.	Area (Ha.)	No.	Area (Ha.)	No.	Area (Ha.)			
24,516	8,128	7,619	211	23	234	34	7	5,323	1,238,549	366	105,005	2,439	1,145,855	1,895,615	593,795	6,151,466

SOURCE: Statistics Canada: Census 1976. Catalogue No. 96-809, Table 13. Alberta Agriculture.

(1,145,855). The predominance of private owner-operator land area may, in part, be due to the fact that under this arrangement, private individuals have the most freedom for decision-making and the greatest security of rights. Also, the economic efficiency under private ownership tends to be greater than under part-owner and part-tenant ownership arrangements (Marothia 1977). Under part-owner/tenant, the farmland may be used with greater intensity, thus increasing soil erosion potential. Ownership arrangements are most important in investigating soil erosion processes and their effect on efficiency and equity.[7]

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[7] These issues are discussed in Chapter VIII.

III. Foundation of Logical Inferences in Resource Policy

This chapter serves as a preface to the analytical framework. Section A searches the philosophic foundations of ethical choices and competing ideologies with respect to resource ownership and human interaction. This section also traces the foundation of the ideas wherein the components of natural resource policy (i.e., rights, power, freedom, security, interest conflicts and interdependence), lie. These components of resource policy are discussed in Section B and resource problems are treated within the structure of these components. Ambiguities in the neoclassical economics approach and its inadequacies with respect to the above components of resource policy are considered in Section C. It is deemed most important to attain a thorough understanding of the interrelationships among policy variables and to identify an appropriate approach to deal with these variables. Thus, Section D proposes a better choice: Commons' institutionalism and a neoclassical synthesis.

A. Economics, Social Values, and Human Behaviour

The roots of the study of economic problems stem from the moral science. Since the origin of the economic discipline, economists who belong to the various schools of thought have been analyzing human behaviour, relationships among institutions that shape man's behaviour and society's value system, all within the framework of scientific inquiry that involves drawing logical inferences from their knowledge about facts. While approaches to dealing with human behaviour and control of resources may differ from hedonic, classical, neoclassical and marxist economics to institutional economics, the focus has always been on the core issue of how to channel individual behaviour into socially beneficial manifestations. In other words, the focus of economists' moral, legal and economic research has been on devising an appropriate analytical framework within which an individual's freedom, security and rights, as well as justice, can be expressed without inflicting harm on others in society.

An economic framework developed by Locke (1690), Smith (1759, 1776), and the classical economists, the neoclassical economists, and the Chicagoans found social virtue in the outcome of a myriad of independent decisions, each based on individual self-interest.[8] Locke and Smith founded their theories on the relations of man to nature. These theories are individualistic since they are concerned with relations between individuals and nature or among individuals. Central to Locke's and Smith's theories were the importance of labour expended to acquire commodities and the importance of commodities in providing enjoyment by ultimate consumers. In either case, the relationship between human behaviour and control of resources or property underlies the concept of natural rights and self-interest. Smith's framework of moral philosophy illustrates the type of man he wished to idealize. Smith (1759, p. 32) says, "... that to feel much for others and little for ourselves, that to restrain our selfish, and to indulge our benevolent affections, constitutes the perfection of human nature; and can alone produce among mankind that *harmony* of sentiments and passions in which consists their whole grace and *propriety*" [emphasis added]. Smith[9] had, thus, seen a basic harmony within the operation of market forces, although he had suggested a conflict in that "landlords love to reap where they have never sowed" (Smith 1776, p. 420). Smith's advocacy of laissez faire assumes the existence of competitive markets and he argued against government intervention in the economy based on political, philosophical and economic grounds. He argued that, in general, any government interference is undesirable since it infringes upon the natural rights and liberties of individuals (Smith 1776, pp. 328-329). Smith disapproved of the contrasting ideas of Mandeville (1924), although they both started with the same assumption as to the "egotistical nature of man". Mandeville felt that the pursuit of individual self-interest would have many undesirable social and economic consequences and therefore built a strong case for government intervention in the economy (Landreth 1976, p. 37).

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[8] See the Chicago School Symposium, *Journal of Economic Issues*, 9 (December 1975) and 10 (March 1976); "Symposium on Property Rights," *Natural Resources Journal*, 15 (October 1975): 640-780. See also Randall (1978a).

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[9] See Rosenberg (1960) for institutional aspects of Smith's economics.

Like Smith, the other classical economists, Ricardo (1817), Malthus (1798), and Mill (1929) continued to focus their analysis on the relationships between nature and people to a great extent. However, Mill's view of the good society and resource control reflects a blend of classical liberalism with social reform. Mill says that the only rightful exercise of power by government over an individual against his will is to prevent harm to others. His own good, either physical or moral, is not a sufficient warrant for such action (Mill 1913, pp. 6-7). In Mill's opinion, absence of government intervention does not necessarily result in maximum freedom since there are many other restraints on freedom which only legislation or other government actions can resolve (Mill 1929, p. 818).[10] Building on the foundation of Ricardian rent theory (1817), he condemned landlords who "... grow richer, as it were, in their sleep, without working, risking, or economizing. What claim have they, on the general principle of social justice, to this accession of riches?" (Mill 1929, p. 818). His treatment of private property in land is within that system which blends classical liberalism with the humanism of social reform to bring about a society with an economy less concerned with the art of individual improvement and self-fulfilment. In

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[10] Some modern economists argued the same thing in the context of public choice. Compare the positions of Haveman (1970) and Barkley and Seckler (1972).

Mill's view, property rights are not absolute and society can abdicate or alter the rights of property when it judges these rights to be in conflict with the public good. Mill made important and lasting contributions to economic theory including the wage-fund doctrine, the stationary state, the theoretical system of economic growth and the quality of life.

Although the classical economists had diverse concerns, one theme--individual freedom and physical control of property in the laissez faire system--persisted among these concerns with considerable consistency.[11] This common theme among classical economists, and notably Mill, continued into the concerns of neoclassical economists represented by the marginalists (Walras 1954), Marshallians (Marshall 1890 and Viner 1941), Keynes (1936), and the welfare economists. (Pigou 1920, Pareto 1971, Little 1957 and Mishan 1965). The neoclassical economists (Hayck 1948, Knight 1960 and Friedman 1962), as well as classical economists, believe that the laissez faire system guarantees all manner of desirable economic outcomes and, at the same time, is compatible with the highest conceivable degree of human freedom in which one may do what one wants with one's self and one's property within a framework of minimal restrictions for the common good.

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[11] See Stigler (1949) on classical economists' view of a better man, p. viii.

Power is limited by rights in competition. The exclusive focus of mainstream economics on market competition--the only appropriate role of government is to maintain competition--has been challenged by Marx (1849), Pigou (1920), Clark (1923), Mill (1929), Samuelson (1955, 1958), Robinson (1963, 1971), Shaffer (1969), Galbraith (1971), Solo (1974), and Schmid (1978). Since the Keynesian revolution, mainstream economists have accepted to some extent the role of government in stabilization of market mechanisms. The Keynesian perspective gave the competitive market a place as an important institutional concept. There are still those, however, who ignore this aspect of markets. For example, turning to the money markets, Friedman (1962) would have the money supply grow by a predetermined annual rate and deny any role for periodic government change in monetary policy. In short, market competition deals with power, freedom, rights, security and efficiency in a passive and effectual manner.

The neoclassicals saw a harmony of interest arising through voluntary exchange from the interaction of independent and entirely selfish individuals. The institutionalists, working from a much more complex concept of human motivation and social organization, saw conflict as the predominant phenomenon and, as a result, raised fundamental questions about neoclassical methodologies (Liebhafsky 1976 and Randall 1978a). According to the institutionalists, neoclassical economics has been very narrow in the selection of variables for consideration, extremely abstractive and simplified in its approach to society and inadequate with respect to human interdependence and relations to the environment.[12]

The institutionalist approach has been strongly oriented toward defining relationships among individuals with respect to resource utilization and other economic pursuits (Ely 1914, p. 96). The term "institution" as defined by Commons (1934a, p. 21), "... is collective action in control, liberation and expansion of individual action." One institution, namely property, is defined by Parsons (1942) as follows: "Property is a set of social relationships which ties the future to the present through expectations of stabilized behaviour regarding other persons and things". Ciriacy-Wantrup (1969, p. 1319) conceptualizes an institution as "a social decision system that provides decision rules for adjusting and accommodating, over time, conflicting demands (using the word in its more general sense) from different interest groups in a society." Schmid (1972, p. 893; 1978, p. 6) defines institutions including property as "... sets of ordered relationships among people that define their rights, exposure to the rights of others, privileges and responsibilities." The terms "institutions", "rights" and "rules of the game" are used in various definitions more or less interchangeably, though there are slight differences in the degree of aggregation and abstractness implied. The definitions of Parson, Ciriacy-Wantrup and Schmid are similar to Commons' collective action theme. Considerable emphasis on Commons' institutional economics is given herein.

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[12] This narrow emphasis of neoclassicals has been criticized by the German historical school (see Dorfman, 1955), Veblen (1889, 1904, 1919, 1921, 1923), Ranade (1920), Commons (1924, 1931, 1934a, 1950), Mukerjee (1942, 1950, 1960, 1964), Mitchell (1913, 1937), Clark (1957), Ayers (1944, 1961), Myrdal (1955, 1960, 1973, 1978), Galbraith (1958, 1971, 1973), Parson (1941, 1942, 1949, 1974), Salter (1948), Boulding (1957, 1958, 1970a, 1973, 1975), Gruchy (1947, 1969, 1972), Kuznets (1963), Robinson (1963, 1971), Ward (1972), Shaffer (1969), Kelso (1977), Schmid (1978), Elliott (1978) and many other scholars in that tradition.

Commons (1934a) viewed collective action as expanding and liberating as well as controlling individual action and ranges from organized custom to organized "going concerns". Collective action, as well as individual action, is influenced by scarcity which is "... universal for all economic theory" (Commons 1934a, pp. 6-7). In the face of scarcity, according to Commons, self-interest breeds conflict and disorder. Conventional economics focuses essentially on man-to-nature or man-to-himself relations and in the conventional view, scarcity leads to individual economizing choices. By contrast, Commons' institutional economics focuses upon man-to-man actions or "transactions". Ownership "becomes the foundation of institutional economics" because ownership interacts with scarcity to create conflicts of interest which are "predominant in transactions". But transactors are mutually interdependent as well as conflicting. Because of this mutual interdependence, Commons suggested that the alienation and acquisition of "rights" of future ownership of physical things among individuals "would be negotiated between the parties concerned, according to the working rules of society," thus creating a "certain security of expectation" or "order" as distinguished from neoclassical "equilibrium" or "harmony" (Commons 1934a, pp. 53-54). Thus Commons rejected the conventional concept of natural rights. To him, rights are relative, evolutionary and subject to change or limit as power relationships and societal needs or values change. Thus Commons' institutions are the behavioural rules that tend to shape man by infuencing his patterns of thoughts, behaviour and expectations, and that liberate him by providing security and limitations on the actions of others which might impinge upon him. The institutional economics of Commons emerged as a result of his unusual intellectual synthesis of the theories of sociology, law and economics. He brought to economics an institutional approach wherein the foundation of logical inferences for natural resource economic research lies.

B. Components of Resource Policy

As societal needs change, so do our rights. Some elaboration of individual rights is necessary to gain a clear understanding of the problems of resource policy analysis. Working from the ideas of Commons, Long (1953) argued elequently the importance of freedom and security as policy objectives and examined the implications of the widely-held idea by "...both laymen and economists that freedom and security are somehow inherently incompatible--that any public policy decision involves a choosing of how much of one of these great value objectives we want at the expense of the other" (Long 1953, p. 318). He calls our attention to the notion of rights of individuals:

> Liberty or freedom *in the completely abstract sense* is in reality meaningless. It becomes meaningful only in specific terms which must include a structure of opportunity which makes the realization of the freedom possible. *Any freedom enjoyed by any individual consists in a set of securities of expectations concerning the behaviour of other individuals and groups*. These secure expectations of an individual result from a *system of rules - rights, duties, restraints*--developed by processes of public action and enforceable by law--which determine what others may and may not do. Freedom does not "*inhere*" in an individual. Any individual freedom exists in consequence of the public organization which defines this freedom and secures it for the individual against the adverse action of others. The slave became a free man, not in virtue of anything new put into him, but in consequence of a set of restraints imposed upon others. *The difference between a free man and a slave is that the free man has security in the knowledge that the forces of public action will be used to limit the activities of those who would do him harm or use him against his will for their purposes*" (Long 1953, pp. 318-319) [emphasis added].

The recognition that rights are subject to limits and changes (Commons 1931, p. 648), that is, the nature and extent of rights change and individual freedom is subject to sanction, is fundamental to a clear understanding of any natural resource policy analysis. Rights are the instruments by which any society controls and orders human interdependence and resolves the question of who gets what (Parsons 1941). In the absence of rules that govern through social organization, human relations settle down to a sheer play of power against power--a "war of all against all", in which individual life is "solitary, poor, nasty, brutish and short" (Long 1953, p. 321). Alternative rights are of interest because of their effect on economic performance and outcomes (Schmid 1978, p. 5). Rights define potential opportunities and the opportunities of one person are shaped by the opportunities of others (Samuels 1972). "Thus the opportunity sets of an individual are composed of alternative lines of action that are open because of the relative structure of rights as well as the relative capacity of the person to make use of those rights. The value of a right is also limited by available knowledge and technology. The opportunity sets of individuals interact and condition the outcome of human transactions. The components of the institutional structure are then one of the points of leverage in changing outcomes" (Schmid 1978, p. 7).

A basic shift in the structure of rights is evident in many problems of natural resource economics. For example, the Canada Water Act of the 1970s (Maclaren 1972, pp. 80-82) and the Clean Air Movement of 1968 by the Province of Ontario (Dales 1968, p.55) started out as a confrontation over traditional presumptions concerning property rights. Until that time, very few Canadians questioned the use of their air and water resources. But when dirty air and water became increasingly noticed, the obvious question was: who is using that natural resource? With the realization that resource quality was lower than before and fuelled by the realization that individuals and groups can work to change certain behavioural rules of society (Bromley, 1976b), the presumptive property rights for air and water, long in the hands of the producers of commodities, was called into question. Property rights are shifted and working rules are altered since they are the expectations of what individuals can or cannot do, and since they are controlled, liberated or expanded by collective action, under this new set of working rules, the situation is completely changed. For example, the fisherman used to petition the polluter to cease and desist, whereas the petition must now, in most instances, come from those who wish to dump wastes. In this new situation, the polluter cannot ignore the social costs of production activity in the form of external diseconomies. There could not be clearer evidence of a fundamental shift in presumed property rights.

The example of the shift in the structure of rights outlined above emphasizes human interdependence and interactions. The interdependence can be described in terms of institutionalized cost (or transaction cost in Commons' terminology), external effects and power. As Commons (1934) suggested, one person's right to act really means that others are limited in avoiding the consequences of that act.[13] In his new rights, A's liberty, immunity, or freedom can be seen as the lack of freedom or exposure of B to A's acts. The right of A is a duty in B to allow what A claims under the right. One person's freedom is another's limitation if interests conflict in the face of scarcity. Thus property is not simply a derivation of a physical fact. It also reflects a social choice of the kind of efforts that are counted in creating an image in an individual's mind about the knowledge of a person's rights. A community usually defines property rights either by a common problem or by the mutual advantage of joint action (Schmid 1978, p. 28). Institutions emerge whenever it is profitable (Schultz 1968), but a public requires organization; an organization implies community; a community implies a clustering of benevolence functions which denies the assumption of independent utilities (Boulding 1970b). Demands for institutional change may originate from different groups in a society. Furthermore, "changes in economic institutions are usually slow and often require the political arena rather than the market place" (Ciriacy-Wantrup 1969, p. 1319).

Commons' institutional framework with its profound insight involves the decision-making capabilities of individuals to form stable expectations about the behaviour of others by knowing the working rules that will facilitate the organization of human endeavours. Since the components of resource policy analysis--rights, power, freedom, security and human interaction--remain the province of Commons' institutional economics, the approach used here largely comes from Commons' foundations of policy analysis.

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[13] These concepts are discussed in more detail in Chapter V.

C. Ambiguities in the Neoclassical Approach

The institutional approach of Commons is pragmatic. The philosophic approach to this pragmatism[14] can be traced to Dewey (Johnson 1962 and 1981). The institutional framework of Commons is a detailed and valid description of real world problems. While Commons' model has not been accepted by mainstream economists--not because it is ambiguous, but because it has not been well adopted to the mathematical technology of its day--his ideas have been influential among land economists and many other institutional economists (Randall 1978a, 1978b). These economists have used Commons' ideas *per se* (Parson 1941 and 1942, Schickele 1941, Gruchy 1947 and 1972, Long 1953, Timmons 1959 and 1972, Dorfman 1968, Kapp 1968, Gonce 1971 and 1976, Barlowe 1972, Goldberg 1974, 1976a and 1976b, Kanel 1974, Kelso 1977 and many others), or in modified or slightly extended forms (Boulding 1957, Galbraith 1971 and 1973, Mydral 1978) and, at the same time, internalized most of the theory and methodology of neoclassical economics which have antecedents in institutionalists' thoughts (Ciriacy-Wantrup 1952; Ostrom 1971, 1975 and 1976, Schmid 1972 and 1978, Samuels 1974, Bromley 1976a and 1978, Castle 1978, Randall 1978).

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[14] In his excellent work, Salter (1946) attempted to promote scientific method as conceived by Dewey (1922, 1935, 1967) for use in land economic research. The instrumentalist approach of Dewey was then replaced by Popper's (1957) scientific method (Hildreth and Castle 1966).

However, a few resource and agricultural economists have treated institutions in a manner somewhat at variance with the work of Commons. For example, Ciriacy-Wantrup (1952) treated institutions by bringing them explicitly into the analytical framework of economics (Castle et al. 1981). Johnson (1962) notes that Ciriacy-Wantrup utilizes contributions of Commons as well as "rationalist" and "positivistic" thoughts, but that his basic framework comes from neoclassical economics (Castle, et al. 1981). However, Ciriacy-Wantrup himself conveyed the message that his thoughts are firmly grounded in the philosophy of German institutionalism.[15] This may be the reason for the common thoughts of Commons and Ciriacy-Wantrup on various issues. In the opinion of this writer, it would be a worthwhile exercise to analyze Commons' and Ciriacy-Wantrup's views in a more creative way, to assist in the natural resource economics profession in dealing with various complex economic problems.

A few other agricultural economists with predominately neoclassical thinking also utilize Commons' ideas in part in analyzing both "institutional and technical change". Foremost contributors are Schultz (1968), Binswangar and

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[15] Personal communication with T.W. Manning and W.E. Phillips.

Ruttan (1978), and Hayami and Ruttan (1971). One enduring theme in this induced institutional innovation literature is the interplay of institutions[16] and technology, and whether or not one necessarily precedes the other in matters of economic change (Runge and Bromley 1979, p. 1). Furthermore, the induced institutional innovation hypothesis is based on the Darwinian natural selection model which is exceedingly naive compared to Commons' model of institutional evolution by deliberate social selection (Randall 1978a).

There is yet another group of mainstream economists who identify with the "property rights approach" including Coase (1960), Alchian and Demsetz (1973), Demsetz (1967) and Furubotn and Pejovich (1972). In a similar vein, those writing about political science, law and administration, who may be identified with "public choice" or "social choice" theory, include leading contributors such as Down (1957), Black (1958), Riker (1962), Arrow (1963), Buchanan and Tullock (1964), Tullock (1964), Dahl (1970), Niskamen (1971), Rae (1971), Rawls (1971), Sen (1971) and Olson (1975). Recently, the property rights concepts have been combined with notions of institutional change, primarily in the writings of North and Thomas (1970, 1977), and Davis and North (1970), which can be referred to as the "economic anthropology approach". All three approaches stem from the same vein of neoclassical microeconomic theory, yet can be safely referred to as the "property rights approach".

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[16] See Ciriacy-Wantrup's critique of Schultz's institutionalism (1969). Also see Castle, et al. (1981) for a view of Ciriacy-Wantrup/Schultz conversation.

The property rights school argues that, in a market oriented society, completely defined and specified property rights held by individuals result in internalized beneficial and harmful effects, that is, the property rights approach tends to view Pareto-efficiency and Pareto-safety as acceptable welfare criteria.[17] The "public choice" approach treats basically normative questions as scientific propositions. It determines the most advantageous strategy for each participant in light of opportunities inherent in different rule structures (and assumes each individual will behave accordingly) within a hedonistic model of human motivation. For example, a theory by North and his co-authors is based on two basic premises: (i) all common property resources are depleted; and (ii) all hunting and gathering territories are common property. With this property rights paradigm they develop a reserve use base.

All three approaches above proposed by mainstream economists are criticized by many resource economists.[18] Since this critique has been reported in detail elsewhere (Castle, et al. 1981 and Randall 1978a), only some major elements of this critique are summarized here. Each approach is entirely consistent with the microeconomic theories of production, consumption and exchange and with the welfare concept of Pareto-optimality. The seminal article of Coase (1960) brought to economics that which is now called the property rights approach. Coase's article was attacked on grounds that "the exalted position afforded Coase's contribution appears to be due less to the novelty of his argument than to the selective ignorance of Commons and Clark" (Goldberg 1976, p. 887). Be that as it may, natural resource economists view Coase's approach as not being appropriate for large scale externalities of the type that become social concerns. Most natural resources are non-exclusive and indivisible in character and many individuals must be involved in any potential internalization of trade which yields massive transaction costs. Assuming zero transaction costs and no income effects, the assignment of rights is allocatively neutral. Furthermore, when coupled with the "laissez faire solution" of the Coase theorem, there is no economic distinction among rules and the burden of the costs of pollution control is placed on polluters and receptors (Mishan 1971, Randall 1971, Bromley 1978). The property rights approach only deals with the secondary question of carrying out the logic of costs implicit in a given rights distribution, and not with the broader question of the original and subsequent vestures and rights among individuals (Schmid 1976). Take, for example, the concept of freedom: the neoclassical concept of freedom suggests that the poor with endowments that effectively keep them out of the market are nevertheless free because the market is free (Friedman 1962). On the other hand, a paradigm inspired by Commons and used by Samuels (1972) shows that freedom is defined by the opportunity set, and income, wealth and the rights constraint restricts the individual as much as any other constraint. A poor man, and his children are less free than the rich.

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[17] See Chapter IV for detailed discussion.

[18] For a property right critique, see Dolbear (1967), Kneese (1970), Mishan (1971), Randall (1971, 1974, 1975, 1978a, 1978b), Goldberg (1974, 1976a, (1976b), Samuels (1974), Schmid (1976, 1978), Bromley (1978). For a public choice critique see Ostrom (1971, 1975, 1976)and Randall (1978a). For an economic anthropology approach critique, see Runge and Bromley (1979).

Commenting on the public choice approach, Ostrom (1971, 1975, 1976) says that proponents are more apt to refer to rule structures as rules of the game rather than structures as working rules of going concerns. The emphasis following Commons, however, is upon the logical implications that follow when individuals choose strategies in light of the opportunities inherent in the different rule structures. Rules are viewed as constraints that order human conduct and thus are instrumental in evoking predictable consequences. One may conclude that "public choice" advocates developed a positive approach to institutional analysis, but as Samuels (1974) indicated, the approach has an element of self-delusion. A property rights paradigm proposed by North and co-authors, for instance, suggests that institutions seem to change in response to pressures for gain on the part of entrepreneurs. Once the change in the institutional structure is accomplished, a change in technology quickly follows suit. Runge and Bromley (1979) commented on the adequacy of North's and co-authors' model. They questioned whether or not any meaningful conclusions could be drawn in the absence of institutional change (property rights change). In their view, the model of North and co-authors is similar to a Malthusian model with entrepreneurial gain as the determining factors--a gain which is a function of the exclusivity of property arrangements.

The above arguments suggest that mainstream economists do not really understand the complex nature of institutions. These institutions are not all property and not all rights (Gonce 1976; Goldberg 1976b; Leibhafsky 1976 and Lowry 1976). The failure of mainstream economists to understand the fundamental nature of institutions not only seriously undermines their analysis, but their recommendations as well. As Commons explains, institutions express a society's value system and gives effect in the form of the working rules. Institutions must be broadly consistent with the ethical values of society in order to be reasonably stable. The preoccupation of neoclassical economists with means rather than ends limit the ability of its adherents to understand working rules which institutionalize both means and ends (Gruchy 1969, Randall 1978a).

D. Search for a Better Choice

It is evident from the serious critique of institutional economists that the approach of mainstream economists in dealing with human interdependence and relationships among individuals and individual ownership and control of resources, is too narrow and naive in nature. But this critique raises two important questions: Do the institutional economists have a better alternative? Should institutionalists remain clearly separate from mainstream economists? The answer to the first question seems to be yes. Many institutionalists make a distinct alternative formulation of economics. Three areas, (1) an analysis of property rights and individual behaviour,[19] (2) a framework to analyze irreversible consequences of endangered species and resources,[20] and (3) an institutional approach to public choice,[21] are all major potential contributions that institutionalists have made in order to understand human interaction and in order to analyze interdependencies in a society. The answer to the second question is certainly no. At least Commons did not seem to think so. Commons insisted that his legal economics was in no way an alternative to mainstream economics, but a complement intended to expand it and permit the achievement of its fullest potential (Commons 1931, p. 648). Thus an institutional-mainstream synthesis seems appropriate in order to produce a superior, informative and humanized economic formulation. Several institutionalists see opportunities for a synthesis of Commons' ideas with the mainstream approach (Boulding 1957, Gonce 1971 and 1976, Goldberg 1974, 1976a and 1976b, Ostrom 1976, Kelso 1977, Castle, et al. 1981, Randall 1978a). A recent work by Schmid (1978) is an excellent milestone attempt in this direction. Schmid, through careful analysis, derives many testable hypotheses which not only complement mainstream economics, but provide superior economic formulations to existing mainstream frameworks in the area of property, power and public choice.

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[19] Among leading contributors: Samuels (1972, 1974), Randall (1974), Ciriacy-Wantrup and Bishop (1975), Yandle (1975), Coelho (1976), Bromley (1976a, 1978), Schmid(1978), Veeman (1978), Runge and Bromley (1979).

[20] Major contribution is by Krutilla (1967), Ciriacy-Wantrup and Phillips (1970), Phillips (1976) and Bishop (1978).

[21] Barkley and Seckler (1970), Ostrom (1971, 1975, 1976) and Schmid (1978).

The approach to be used in the present study is similar to that of Schmid's, but the major framework comes from Commons' foundations of policy analysis. The focus here is on the manner in which a particular institution or set of institutions (working rules) affects individual freedom, securities, rights and individual views of efficiency, output and equality which dominate when individuals' interests are in conflict in an interdependent situation. The intellectual foundations upon which logical inferences can be applied to a complex problem such as soil erosion in which private rights, efficiency, equity, resource use rates and human interaction are woven in an interdependent world. This foundation lies with Commons' legal and economic concepts. To this end the research herein is directed toward the development of an analytical framework.

IV. Analytical Framework

The main purpose of this chapter is to develop an analytical framework that deals adequately with the issues centered on private landownership and soil resource use. In Section A farm operators' rights and soil resource use are analyzed in terms of interdependencies, transaction costs, externalities, power, and various financial incentives. Water induced soil erosion processes, factors affecting soil loss, and private and social losses due to soil erosion are discussed in Section B, along with a proposed set of institutional arrangements which can reduce soil loss at the farm level. Quantitative and qualitative characteristics of the soil resource are discussed in Section C. Also included in this section are methods of quantification of soil loss measured in terms of tonnes per hectare per year which are shown to be inadequate and devoid of qualitative characteristics of the soil resource. A characteristic approach is proposed to analyze soil loss and farm operator behaviour. Finally, in Section D, a proposal to analyze the response of farmers and extension workers to existing and alternative soil erosion control policies is outlined.

A. Soil Resource Use and Private Land Ownership

Soil losses from water induced erosion in the Peace River region may be attributed to soil characteristics, topography, intensive summer rainfall, rapid snowmelt, current farming practices (including the removal of all crop residue), extensive summerfallowing and farmers' perceptions of current soil uses. All of these factors result in fertility depletion and soil deterioration. The term depletion refers to the removal of plant nutrients and organic matter through crop removal and leaching, but can be replaced within reversible limits by the use of fertilizer, manure, lime and good management practices. Soil deterioration implies a loss in the value of the soil as productive capital resulting from damage to its physical properties (Bunce 1942, p. 13).

If a farmer fails to maintain soil productivity because of his short-run perceptions of soil resource use, ignorance or other factors, both he and society lose, but the loss may not be irreparable. In general, the farm operator tends to be price responsive. He will increase the intensity of fertilizer application and other productive factors when prices of agricultural products rise or costs of production fall. In such cases society need have little concern unless failure to use the resource fully to achieve a larger required agricultural output becomes a social menace. In the case of soil deterioration, mining of the soil would only be economic for the individual up to the point where the marginal returns from disinvestment equalled the value of the resource destroyed. Thus, from a purely economic point of view, to the extent that the resource can be replenished, soil erosion represents a permanent reduction in rent-earning capacity within reversable limits. This distinction is frequently one of the relationship between the costs of restoring soil productivity to its previous level and the sum of annual costs (including interest) of maintaining that level. Many farmers make no allowance for the depreciation of land values resulting from soil loss in their net returns calculus. Furthermore, farmers are often not aware of the fact that erosion is destroying the soil resource, particularly if it is confined to sheet erosion. They treat net income as if it were net returns and make no allowance for the losses in the value of land. As a result, the use of erosive practices implies lower costs which tend to be reflected in higher net returns than would otherwise result under soil erosion control practices. Furthermore, these returns may become capitalized into excessively high land values from a society viewpoint. This overvaluation of land tends to force soil erosive farming operations to intensify, more than would be the case if soil erosive practices had not led to the higher capital values of land. Consequently, farmers perceive higher rates of return from factors of production under soil erosive farming practices than otherwise due to ignorance toward depreciation of soil resource values and short-run perceptions (Bunce 1943, pp. 80-90).

Soil erosive practices tend to yield annual net returns in the current year which are greater than those under soil erosion control practices. In soil conservation the redistribution of use rates is in the direction of the future, whereas in depletion, they are in the direction of the present (Ciriacy-Wantrup 1946, 1948 and 1961). The difference between rents under soil erosive and soil erosion control practices vary with changes in techniques, changes in the magnitudes of market signals, price structure and interest rates, and farmers' perceptions of soil use. An obvious deficiency of competitive prices is the fact that competitive prices are market prices and not long-run "normal" prices. They tend to reflect more immediate factors and may move a long way from the normal levels. This has been particularly true for land values (Bishop 1973, pp. 101-122 and Phillips 1973, pp. 123-126). In many cases, prices, including interest rates, are not fully competitive and do not accurately reflect future expectations even where these are known (Hicks 1938, p. 226; Bunce 1943, pp. 99-100). Also, when the divergence between individual and social interests is considered, the difficulties are further increased by the necessity of introducing concepts of social discounting. For example, suppose that a farm operator is mining Peace River soil more rapidly than considered desirable for society because the individual's time preference (his preferences for soil use now, rather than in future), is greater than social time preference. One may fail to ask whether or not other reasons exist for rapid individual soil exploitation activities and neglect to analyze the basic causes of the divergence between social and private interests. The difference between social and individual time preferences establishes a universal cause of soil mining activity which obscures, rather than reveals, the real causes, which may be very specific and far removed from philosophic and moral generalizations (Bunce 1940). Thus society is justified in investing in soil conservation measures under situations in which interest rates and expected returns make it impossible for individuals to do so. But society should be aware of the costs to the community and should be clear about the basic problems (Ciriacy-Wantrup 1942, 1947 and 1951).

Social action to induce conservation practices may be unrelated to the basic causes of depletion if such action is undertaken on the assumption that it is necessary because of time preference differentials between society and individuals. Under most formulations of social time preferences, no limit to public action can be established. All exploitation becomes antisocial. The possibility of establishing any rational resource allocations is destroyed.[22] This incapability is probably the greatest weakness of social time preference arguments (Bunce 1943, pp. 99-100). Thus, market signals fail to incorporate real causes of soil losses, for example, dominance of custom, inertia or resistance to changes in farming practices, major institutional changes, and lack of knowledge.

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[22] Much of the recent literature on social discount rates has attempted to integrate opportunity cost rates and social time preference rates. See Marglin (1963), Baumol (1968), Usher (1969), and Dasgupta, Sen and Marglin (1972).

Failure of the individual to maintain soil productivity at the point where conservation becomes socially economic, means that a permanent social loss takes place and society is justified in initiating action to prevent or reverse it. In other words, social action to achieve conservation, where it is economic for individual farm operators to do so, is justified on the basis that it will increase both individual and social net returns. For example, a Peace River farmer may realize that his present farm operations are damaging the soil and that a change might make it possible to conserve this soil and increase income. Hence, he may continue his present practices because the benefits seem insignificant, at least in the short-run, compared to the effort involved in a change. In many cases yield, as well as soil productivity, can be improved and erosion decreased by simply adopting conserving rotations, tillage systems and other measures. Furthermore, in the Peace River region some soil erosive practices were developed when the land was rich in virgin fertility, and while originally economic, became uneconomic as fertility declined. Yet, soil erosion has continued in the Peace River area because of outmoded practices (such as summerfallowing, crop residual removal and stubble burning) which are sustained by institutional arrangements associated with them and which, in turn, act as retardants to change.[23] In the case of uneconomic soil resource use in which both topsoil and fertility loss occur, present net returns as well as future net returns are reduced and irreversible destruction of soil resource occurs. Society is justified in making expenditures to prevent such permanent soil losses, but the preventive measures should apply to the basic causes associated with this erosion problem.

Where soil losses are costly to the farm operator, as well as socially, a case for social action is strengthened. Public policy and action can be formulated only after the basic reasons are understood as to why Peace River farmers continue erosive farming practices when it is not economic for them to do so and higher net revenues in the long-run could be obtained from soil erosion control farming practices. For example, if soil erosion control practices are expensive, financial incentives may be appropriate in attacking the problem. If there is a lack of technical knowledge, then demonstration and education programs may be appropriate. If farmers' perceptions, customs, and resistance to change are major factors, then cost-sharing arrangements to alter their behaviour may be necessary. A comprehensive attempt to establish soil erosion control practices at the farm level should be based upon information regarding the causes of soil loss. Social action may affect individual actions through persuasion, financial incentives or coercion which result in changes in property rights and places limits on individual rights (Commons 1934, p. 145). To this end, the research herein focuses on social action through limits on private landownership and soil resource use.

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[23] This opinion is widely held among professional agriculturalists in the Peace River region. See Also Chapter VII.

Private ownership of land is the cornerstone of our agricultural system. Private landownership in Canadian agriculture carries with it the idea that the farm operator has certain undeniable rights over how that land is used. But, as indicated from previous discussion, certain actions are outlawed, if for no other reason than to protect the liberties of others. When attention is turned to privately owned agricultural land, the issues of specification of ownership rights and use of soil resource become more complex, and the ethical aspects become more pronounced. A Peace River farm operator's use of soil is not only a primary concern to him but is of interest to others (property owners and non-owners) in both spatial and temporal dimensions. A farm owner's use of his land improperly may erode soil from an uphill farm and deposit it on the land of a downhill farm. Soil resource management ceases to be an individual matter. However, movement of eroded soil particles through water shows no respect for artificial ownership boundaries drawn between and among farms. If only two farmers (property owners) are involved in this transmission, and if they can agree on a solution to the problem, then there would perhaps be little cause for further concern. However, there is a large number of farm operators (property owners) on both ends of the erosion problem. Further, erosion transmission also affects people who want to fish, people who want to swim, those who want a peaceful vista and who want low food prices (non-property owners). This illustration represents the spatial dimension of the problem. Present soil use is also of interest to future farmers and food recipients (non-property owners). Thus, public interest in the manner in which soil is used spans both a spatial and a temporal component (Phillips, DePape and Brook 1976; Sharp and Bromley 1979b). The problem then appears much like the "war of all against all" and simple answers to complex problems are neither helpful or realistic.

To resolve these interdependent conflicts, it is necessary to specify rights that accompany ownership. When large numbers of farm owners, non-users and future generations come into conflict, whose rights predominate? When different individuals come into conflict, what rights are assigned to farmers (property owners) simply because they own the land? What rights are assigned to individuals (non-property owners) simply because they are individual recreationists or consumers, and what rights are assigned to unborn farmers and future consumers simply because they are not present to represent their case (DePape and Phillips 1976)? Society has been witnessing similar self-interest conflicts including those from medieval thinkers, classical and hedonic economists to neoclassical and institutional economists. Each group is visited in turn. Medieval members of society witnessed the overstocking of unrestricted pastures and the deterioration of livestock due to the lack of specification of property rights and the inability to set up working rules in land use (Dales 1968, p. 57). The classical and hedonic economists believed in physical control of natural rights to commodities and assumed fixity of existing rights to property and to liberty which was not too different from medieval thinking (Commons 1931, p. 657). However, Smith (1759, p. 32) was aware of the possible abuses of self-interest. The purpose of Smith's economic thought was to devise an appropriate institutional framework within which self-interest can be channeled into a desirable social system (Campbell 1967, p. 572). Commons' (1924, p. 47) institutional economics emphasizes legal control of property rights and transfers the classical and hedonic economists' theories of current physical control to future control when goods will be produced, consumed or exchanged as an outcome of current transactions. Thus, Commons' legal control is future physical control.

Like Locke and Smith, the classical economists and the Chicagoans, the neoclassical economists saw a harmony of interest arising through voluntary exchange from interactions of independent and entirely selfish individuals.[24] The institutionalists, unlike the neoclassical and classical economists, saw conflict as the predominant economic phenomenon within the more complex concepts of human motivation and social organization. A recent article by Ciriacy-Wantrup and Bishop (1975, pp. 713-727) points the way to a major potential contribution by showing conclusively that conflicts among owners and between owners and non-owners can be resolved by alternative institutional arrangements.

To resolve the conflict among farm operators (property owners) and between farm operators and individuals (non-property owners) in the Peace River region, it is necessary that the rights that accompany ownership be specified in detail along with the restrictions that apply to ownership rights. Ownership consists of "a bundle of legally defined user rights to an asset". As Coase (1960, pp. 1-44) has pointed out, it is rights, never objects, that are owned, and the rights themselves are always limited by law; "outright" ownership can never, by definition, extend to use of an asset for illegal purposes. For example, when a farmer buys farmland, he does not pick up that piece of land and carry it home. Rather, he acquires certain specific rights to make use of that farmland. Emphasis is on the transfers of rights, rather than on physical transfers and removal of objects. Among the most important transfer of rights are a farmer's right to prevent others from using his land (except with his permission and on his terms), and the right to divest oneself of one's ownership right to the land by selling, leasing, share cropping or renting it to someone else. These well specified relationships among individuals with respect to land use and the penalties for violating these relationships provide the definition of unattenuated property rights (Cheung 1970, pp. 49-70, Randall 1981, p. 148) which constitutes a set of completely specified, exclusive transferable and enforceable rights.

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[24] See the Chicago School Symposium, *Journal of Economic Issues* 9 (December 1975) and 10 (March 1976). See also Randall (1978a).

In a competitive economy, nonattenuated property rights ensures Pareto-efficiency if transaction costs (Crocker 1971, pp. 451-464) in specification, transfer and enforcement are zero. However, these activities are not costless. Alternative property rights arrangements do not only involve transaction costs, but also have implications on economic efficiency and equality (Marothia 1977). Thus the Pareto-efficiency is only achieved if, in addition to all other necessary and sufficient conditions, transaction costs in specification, transfer and enforcement of property rights proceeds to the point at which the marginal conditions for efficiency are satisfied (Randall 1981, p. 149). It is conceivable that different specifications of nonattenuated property rights give rise to different Pareto-efficient solutions. However, a unique Pareto-efficient equilibrium may be achieved only by prior specification of the distribution of resources, wealth and legal rights including property rights. However, Pareto-efficiency alone is not all that is desired. If it is so, then government can simply manipulate the precise specification of property rights in order to achieve its distributional goals. This conclusion is a total misconception: "it fails to recognize the role of property rights within the total institutional structure, and the role of institutions, broadly conceived, in a dynamic society" (Randall 1981, p. 151). Moreover, Pareto-optimality implies the choice already implicit in status quo property rights. To limit oneself to Pareto-optimality only is to express preference for the current distribution of rights and income (Schmid 1978, p. 234).

Discussion returns to the soil erosion problem. The importance of realizing that current soil utilization constitutes external costs to farmers at both ends of the erosion problem, to downhill individuals and to future generations of farmers and consumers in a private landownership or in a nonattenuated structure of rights can not be overemphasized. The current use of soil resources creates inefficiencies that arise when some of the benefits or costs of certain erosive practices are external to the decision-maker's (farmer's) calculus, that is, some of the benefits accrue to, or some of the costs are imposed upon, individuals who play no role in the decision-making process. This result is in contrast to the traditional simple two-party externality situation in which both parties are equal in economic power with each in possession of full information concerning one's own position and one's adversary's position, and in which resource allocation elsewhere is optimal (Buchanan and Stubblebine 1962).

The problem facing the Peace River community involves a large number of individuals who may be characterized as "getting in each other's hair". For a simple externality involving two producers (parties), Coase (1960) and Mishan (1971) suggest two kinds of liabilities for alternative assignments of property rights.[25] In the Coasian solution to an externality, for example, if farmer A is "liable", then A proceeds to divert water onto B's field, knowing that damages will be assessed by a government officer, and that he must pay a second party, farmer B, for damages. This assessment would need to be determined by government officials acting with the force of a soil conservation act or law. Farmer B is protected by a "liability" rule. However, if farmer B is "liable", then farmer B must approach farmer A and pay not to have diverted water in his field. A Coasian solution assumes zero transaction cost and no income effect in this situation. However, an alternative arrangement of property rights can not be achieved at zero cost. The incidence of transaction costs is central to the matter of soil erosion control policies and has a profound effect on the definition of the ideal outcome.

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[25] See Krutilla and Fisher (1975) for a detailed discussion on public and private property rights.

In a recent article, Bromley (1978, pp. 43-60) draws upon Calabresi and Melamed (1972, pp. 1089-1123) who substitute the term "entitlement" for "property rights" and then discuss various types of entitlements in cases of interdependence. Bromley concluded that there are entitlements protected by property rules, and by liability rules, and inalienable entitlements. He also concluded that when the situation involves shifting property rules and liability rules between producers and consumers (or between two consumers), not only do income effects become important, but current endowments and entitlements dominate the outcome as well. Bromley further suggested that in a case of third-party affects, society may choose the inalienability rule. Even though an "upstream" and "downstream" firm may agree on a value of the "river" for dumping waste, all those potentially affected by its use as a sewer are not represented in the transaction. To assume such representation would imply transaction costs so great that a reasonable solution may turn to an inalienability rule which simply precludes the two-party transaction. The analysis by Bromley and Calabresi and Melamed suggests that the alternative specification of rights dominates the final outcome.

For a complex problem such as water induced soil erosion on agricultural land.which involves a large number of individuals and has significant spillovers, Haveman (1970, pp. 39-40) suggests collective action, usually through a government, if efficient performance is to be achieved. In other words, whenever there is a divergence between social cost and private cost, government must step in. Demsetz (1967, pp. 348-49) states, "a primary function of property rights is that of *guiding incentives* to achieve a greater internalization of externalities" [emphasis added]. Several studies which have been conducted to examine the impact of certain agricultural activities on water quality (Seitz and Spitze 1969; Jacob and Timmons 1974; Seitz, et al. 1978, 1979; Taylor, Frohberg and Seitz 1978; Moore, Sharp, Berkowitz and Schneider 1979; and Sharp and Bromley 1979a) suggest three major forms of financial incentives to control agricultural nonpoint-source pollution-tax relief, subsidies and cost-sharing. These studies have indicated the manner in which operators can adjust their land management practices and their operations to most tolerable soil loss standards.[26] All of these studies deal with the issue of stream pollution and financial incentives for nonpoint pollution control, but neglect largely the farm level economics of soil erosion.

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[26] The Universal Soil Loss equation ($A = RKLSCP$) has been utilized in many studies conducted in the U.S.A. and elsewhere to estimate the average annual soil loss (A) from sheet and rill erosion in tonnes per hectare for specific combinations of rainfall factor (R), soil erodibility factors (K), slope and slope length factor (LS), cropping management factor (C) and erosion control practice factor (P). Tolerable values (TV) are assigned to a given field expressing a tolerable limit on annual soil loss. The tolerable values are worked out by substituting CP for A in the equation: $CP=TV/RKLSP$ (Wischmeier and Smith 1965, and Wischmeier 1970).

Very few studies (Phillips, DePape and Brook 1975; Pollard, Sharp and Madison 1979; and Burt 1981) deal with the farm level problem in a localized area or region which is prone to soil erosion. Burt analyzed the effects of wheat production on the depth of topsoil and the percentage of organic matter using a control theory approach, but completely ignored the issue of external effects of soil resource use at the farm level. Pollard et al., suggests that cost-sharing is the most effective means of promoting voluntary adoption of soil and water conservation practices. Phillips et al., analyzed the existing legislative channels to minimize the external effects at the farm level due to water induced soil erosion and suggested a scheme for reducing soil loss at the farm level. Although most of these studies (farm level, on-site and off-site or nonpoint) indicate the importance of financial incentives, they also consider a narrow range of the institutional arrangements and hence do not adequately address the needs of policy-makers. The methods employed in these studies (except in Phillips, DePape and Brook 1975; Seitz and Spitze 1978; and Sharp and Bromley 1979a) are not capable of inducing a change in farm operator behaviour. In most of the agricultural nonpoint-source pollution studies, the decision rule involves the usual profit maximization or cost minimization objective subject to various environmental constraints. This approach does not work, however, because it cannot bear any instrumental burden related to the institutional structure (Schmid 1972, p. 895).

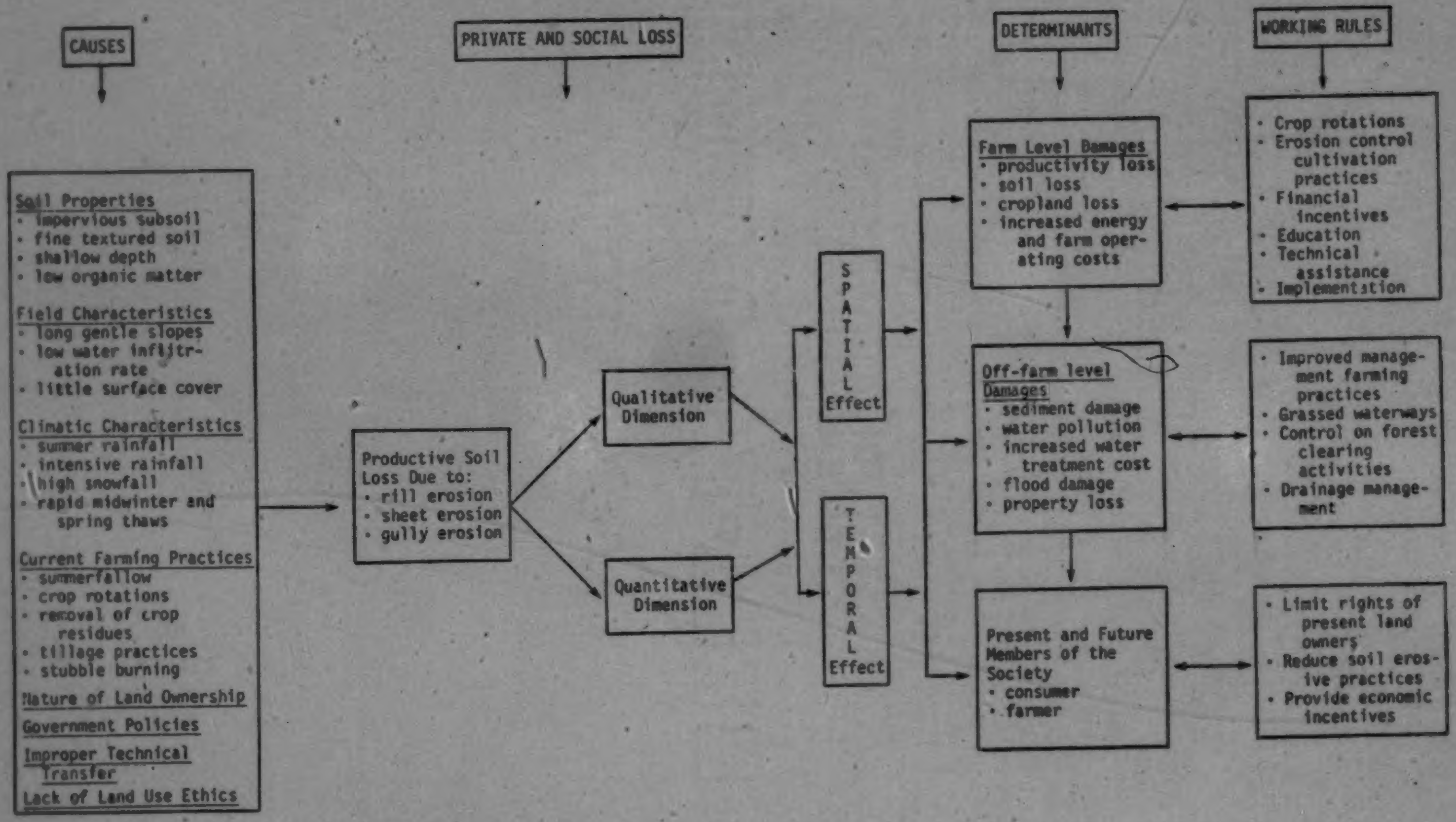
To resolve the complexity of interdependencies and conflicts in the soil erosion problem, it is imperative to identify a wide range of institutional arrangements in order to understand and regulate farm operator behaviour. One of the most pressing issues facing decision-makers and extension personnel in the Peace River region is how to induce change in farmer behaviour towards the adoption of improved soil erosion control practices and away from soil erosive farming practices. Currently, a cost-sharing program to control gully erosion and construct grass waterways is in operation in the Peace River region. However, cost-sharing or other economic incentives are not available to farm operators to encourage increases in conservation tillage, the adoption of expanded continuous cropping or the reduction in summerfallow (a single, most damaging factor of soil loss), or the adoption of improved management practices in the Peace River region of Alberta. Policy-makers have many options available to induce conservation behaviour at the farm level, such as education, technical assistance and financial incentives. All of these options or institutional arrangements or working rules for the management problem involve costs, be they direct costs to the farm operator or administrative and enforcement costs to society at large. In this context, economic incentives assume the pivotal role of inducing the application of soil erosion control practices on an individual farm operator basis. To this end, a more comprehensive framework for viewing water induced soil erosion on agricultural land in the Peace River region is proposed.

B. Water Induced Soil Erosion Process

The flow diagram in Figure IV.1 traces the causes of soil erosion, private and social consequences in the forms of spatial and temporal spillovers as well as qualitative and quantitative soil loss; determinants of soil loss at the farm, nonfarm and societal levels, and the various working rules at each level of the erosion process which can reduce the magnitude of soil erosion. As can be seen from the flow diagram, soil losses from water induced erosion in the Peace River region may be attributed to unique soil characteristics, long gentle slopes, intensive rainfall, rapid snowmelt and current farming practices, including the removal of all crop residues and extensive use of summerfallowing or absence of proper crop rotations. Furthermore, private landownership and lack of land use ethics also tend to result in serious erosion problems in the Peace River region. The current use of the soil resource has both spatial and temporal external effects. These external effects arise because soil has a quantitative as well as qualitative dimension. A quantitative dimension describes soil loss in terms of a loss rate per unit of time at the field level. This statement is a narrow definition of the process that changes the place and form of the soil

FIGURE IV.1

WATER INDUCED SOIL EROSION PROCESS ON AGRICULTURAL LAND IN THE PEACE RIVER REGION


CAUSES
PRIVATE AND SOCIAL LOSS
DETERMINANTS
WORKING RULES
Soil Properties
· impervious subsoil
· fine textured soil
· shallow depth
· low organic matter
Field Characteristics
· long gentle slopes
· low water infiltration rate
· little surface cover
Climatic Characteristics
· summer rainfall
· intensive rainfall
· high snowfall
· rapid midwinter and spring thaws
Current Farming Practices
· summerfallow
· crop rotations
· removal of crop residues
· tillage practices
· stubble burning
Nature of Land Ownership
Government Policies
Improper Technical Transfer
Lack of Land Use Ethics
Productive Soil Loss Due to:
· rill erosion
· sheet erosion
· gully erosion
Qualitative Dimension
Quantitative Dimension
SPATIAL Effect
TEMPORAL Effect
Farm Level Damages
· productivity loss
· soil loss
· cropland loss
· increased energy and farm operating costs
Off-farm level Damages
· sediment damage
· water pollution
· increased water treatment cost
· flood damage
· property loss
Present and Future Members of the Society
· consumer
· farmer
· Crop rotations
· Erosion control cultivation practices
· Financial incentives
· Education
· Technical assistance
· Implementation
· Improved management farming practices
· Grassed waterways
· Control on forest clearing activities
· Drainage management
· Limit rights of present land owners
· Reduce soil erosive practices
· Provide economic incentives

resource. A major reason for this misconception lies in attempts to estimate the rate at which soil is being eroded at the farm level. A quantitative dimension may be a reasonable first approximation. However, it does not indicate anything about qualitative soil deterioration.

Once topsoil is carried away, the remaining soil is of lower quality than the lost soil. When in place, the soil resource is a blend of sand, silt, clay and organic matter. Erosion disturbs this mixture. The selective removal of the organic component reduces the remaining soil's capacity to resist erosion. In addition, it lowers the stock of nutrients and reduces water-holding capacity. While technology may offset the loss, at least in the short-run, some of these qualitative changes and the biophysical features are far more difficult to re-establish (Jacks and Whyte 1939; and Sharp and Bromley 1979b). Hence, both qualitative and quantitative degradation of soil has many social, economic and environmental consequences for present and future generations. A more detailed discussion of the qualitative and quantitative characteristics of soil takes place below in this chapter and in Chapter VI.

The farm level damages associated with erosion include: lost valuable topsoil, lost organic matter, a less desirable soil structure, reduced soil nutrients, increased production costs, reduced yield potential and reduced crop quality. There are often nonpoint or off-farm spatial and temporal damages as well. This research, however, is confined to a farm level analysis. At each level there exists a set of working rules or institutional arrangements which can reduce soil loss (Figure IV.1). For example, the area under summerfallow can be reduced over time by providing alternative crop rotations and proper financial incentives. The practices of crop residue removal, water diversion and conventional tillage facilitate soil loss. However, these practices can be reduced or discontinued by using alternative husbandry. The working rules can be used by the administrative agencies in order to induce altered farm operator behaviour towards the maintenance of socially desirable qualitative and quantitative soil properties. The identification of working rules (or institutional structure) and their implementation to reduce soil loss, resulting from a particular farming practice, is a prerequisite to the efficient use of the public funds and altered soil utilization farming practices.

C. Characteristics of Soil Resources

Current working rules or institutional arrangements are being shaped around estimates of soil loss (measured in tonnes per hectare per year), which ignores the qualitative damage to the soil resource. If this trend continues, then uncertainty, limited foresight and irreversibilities result. It is therefore important to analyze current soil resource uses in terms of their effects on soil characteristics.

Soil is a complex body of minerals and organic matter, a blend of physical and biological materials, and a mixture of living and dead components. Soil is an essential component of agricultural production as well as the biosphere (Ciriacy-Wantrup 1952, pp. 40-42; Held and Clawson 1965, p. 21; and Sharp and Bromley 1979b, p. 2). Soil may be considered an exhaustible but renewable stock resource (Bunce 1942, pp. 1-30; and Timmons 1961, p. 8). Soil particles themselves, above the basic bedrock, are a stock resource, but are exhaustible. As soil particles are carried away, the remaining soil can be damaged permanently, perhaps within a restorable range, but subject to high improvement costs. Also, the stock of soil particles is limited and can be exhausted. The percent of loss affects future use. The organic matter which influences the soil's ability to resist the erosive forces of water runoff, the level of plant nutrients, and the soil structure to an extent, are all stock resources in the sense that the properties were part of the soil before tilled. They are also flow resources in the sense that they change, either naturally or as a result of farmers' uses (Held and Clawson 1965, p. 11). Soil properties can be renewed within the range of reversibility. For example, organic matter provides a supply of organic nutrients and is capable of accomodating use rates that alternate between soil erosion control practices and soil loss, as long as the elastic limits of the components of organic matter are not exceeded. The stress point will vary, however, even if part of the soil itself is washed away or otherwise destroyed and if the process goes too far, restoration to provide an adequate depth of topsoil to sustain agricultural activities may take as long as 7,000 years (Biswas and Biswas 1978, p. 192).

Since there is a grave uncertainty and irreversibility associated with misuse of soil resources and soil has near zero renewal capability, the safe minimum standards of conservation (Ciriacy-Wantrup 1952, pp. 251-168; 1964) should receive much emphasis as an objective of soil erosion control policy. "A safe minimum standard of conservation is achieved by avoiding the critical zone--that is, those physical conditions, brought about by human action, which would make it uneconomical to halt and reverse depletion" (Ciriacy-Wantrup 1952, p. 253). The safe minimum standard of conservation is particularly relevant in the Peace River region where soil erosion may become economically irreversible if stubble burning, removal of crop residuals and other soil erosive practices continue and ultimately result in gully erosion. In the case of soil conservation, a safe minimum standard may be defined by such practices as contour cultivation, mulching, strip cropping and terracing (Ciriacy-Wantrup 1951, p. 38).

In the Peace River region, the thickness of soil ranges from less than 30 cm to approximately 85 cm (Research Council of Alberta 1972). According to current estimates, it takes approximately 40 years to form one cm of soil under normal agricultural practices. Even under the most ideal soil management conditions, soil may form at a rate of one cm in about 12 years (Biswas and Biswas 1978). Based on these estimates, there is likely to be, in most of the Peace River region, a gain of only 0.025 cm every year. Thus, for all practical purposes, one may assume that the soil renewal factor from the substrata is near zero (Sharp and Bromley 1979b, p. 2).

The primary hazards from water induced soil erosion in the Peace River region are physical topsoil loss and organic matter loss. For a given soil in the Peace River region, topsoil depth and organic matter reflect both quantitative and qualitative characteristics. There are many other characteristics associated with plant nutrient levels and soil chemistry, but the loss of topsoil and changes in organic matter are more directly affected by soil erosion in the Peace River region. In most work concerning an economic analysis of soil loss that has been undertaken in the U.S.A. (Swanson and McCallum 1969; Narayanan et al. 1974; Wade and Heady 1977; Taylor and Frohberg 1977; Taylor, Frohberg and Seitz 1978; and Seitz *et al*. 1979), and in Canada (Van Vliet et al. 1976; and Van Vliet 1981), the Universal Soil Loss Equation (Wischmeier and Smith, 1965) is used to predict average soil loss. The most recent estimate of annual soil loss in the Peace River region (Van Vliet 1981) is 13.3 tonnes per hectare, representing an average depth loss of 1.651 cm. of topsoil per hectare. To the farmer, this loss rate per unit of time is insignificant and probably meaningless in terms of profit. However, this estimate ignores qualitative losses from the soil resource. Is the 13.3 tonnes of loss from a field in the Peace River region this year any different from 13.3 tonnes loss over the previous year? While our units of measure may tell us that this loss-rate has remained constant, does this constant quantitative loss indicate anything about qualitative change? Since the soil erosion process may be viewed as involving the removal of undifferentiated particles from farms on the earth's surface, the use of the Universal Soil Loss Equation reinforces this misunderstanding (Sharp and Bromley 1979b, p. 3).

To measure the on-site damage from soil erosion resulting from agricultural practices, Walker (1980) developed a soil loss damage function[27] which allows the

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[27] The specification of a damage function takes into account the following private costs and benefits of choosing the erosive practice:

$$Z_t = Px[Y_e(D_{t-1}) - Y_s(D_{t-1})] - (C_e - C_s) - \sum_{i=t+1}^{T} \frac{Px[Y_s(D_{t-1}) - Y_s(D_t)]}{(1+r)^{i-t}},$$

where: Z_t = the value of damage function in Year t (i.e., the private economic value of choosing the erosive practice over safe practice in Year t); P = price of the crop; Y_e = crop yield with erosive practice as a function of topsoil depth; Y_s = crop yield with safe practice; D_t = topsoil depth at end of year; C_e = variable cost of production with erosive practice; C_s = variable cost of crop production with safe practice; T = number of years in time horizon; r = real private rate of discount. If $Z_t > 0$, the erosive practice will be profitable and economic incentives would encourage "mining" the soil. If $Z_t < 0$, the erosive practice will be damaging and economic incentive would encourage conserving the soil.

evaluation of alternative tillage systems for controlling erosion, taking into account yield damage from cumulative soil losses. Walker's damage function claims to portray the economic consequences from farmer employment of a prevailing erosive practice as opposed to a safe practice. Walker's function, similar to the Universal Soil Loss Equation, at least in concept, estimates the tolerable soil loss for a safe practice over an erosive one. Walker manages to combine the soil loss rate per unit of time with the present value concept. However, this synthesis is misleading in the sense that Walker assumes an asymptotic relationship between crop yield and topsoil depth over time, which ignores the fundamental fact that the soil renewal factor is near zero. Walker's simple concept of the optimal rate of soil loss based on highly restrictive assumptions, fails to understand the complexity of soil characteristics and takes into account only quantitative changes in the soil resource as in the case of the Universal Soil Loss Equation.

Research conducted at an experimental station in Wisconsin clearly indicates the meaning of qualitative change. The findings indicate that topsoil deposited by erosion may appear to be of high quality, but in fact is usually inferior to the soil which it covers (Gile 1955, p. 230; Englestad 1961, p. 498). These findings thus suggest that the quality of soil resource changes (declines). Besides the weakness of the Universal Soil Loss Equation of not being able to include the qualitative characteristics of soil resource, the use of this equation is not appropriate in the Peace River region. As a matter of fact, this equation is basically developed to predict rainfall induced erosion and does not consider soil loss associated with snowmelt. Therefore, in the Peace River region where soil loss during snowmelt is very significant, soil loss predictions with the Universal Soil Loss Equation could underestimate actual soil losses. Similarly, Walker's soil loss damage function only quantifies soil loss rates based on assumptions at low private interest rates, high crop prices, high yield associated with safe practices and low costs of production associated with such practices. All of these assumptions are very sensitive to the outcome of the equation and therefore estimates of questionable accuracy result.

The jointness of characteristics of soil resources is really the key to understanding soil erosion processes. Although soils differ in fertility and other characteristics throughout the Peace River region, two characteristics, namely topsoil depth and organic matter content[28] reflect quite accurately soil fertility for given soils in particular locations. Characteristics of soil resources can be related directly to managerial skill, farming practices and crop rotations which jointly affect soil organic matter content, physical soil loss through erosion, and net returns from the land resource (Burt 1981, p. 84). Farmers' use of soil resources is directly related to qualitative and quantitative changes in soil characteristics over time at the farm level.

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[28] Burt (1981) also used these two variables to capture the essential information in a dynamic optimization problem of soil conservation using control theory. Contrary to Burt, we have used these variables within the analytical framework of Lancaster's (1966a, 1966b) consumption theory. The Burt (1981) article appeared while the writer was working with the same variables.

The soil characteristics model is constructed on Lancaster's (1966a, 1966b) approach to consumer theory. Institutional arrangements are applied to Lancaster's approach in order to specify farmers' behaviour conducive to meeting desired social goals (reducing soil loss). The soil characteristics-farmer behaviour model is constructed and discussed in Chapter VII. No attempt to date has been made in soil erosion research to include soil characteristics within a framework of consumption theory and ~~to~~ relate these characteristics to farm operator behaviour. Soil is viewed as an input which has a bundle of characteristics. These characteristics alone can describe soil adequately. Therefore it is important to appreciate that appropriate working rules have to be established collectively, if one wants to maintain these characteristics to sustain certain agricultural activities using the soil resource. These concepts are discussed further in Chapter VI.

D. Analysis of Responses

In selecting the most effective and appropriate soil erosion control policies at the farm level, policy-makers will need to consider economic, social, legal, administrative and institutional issues. The ultimate success of these policies will depend upon their acceptability by farmers and society, farmers in the sense that they will have to alter their current farming operations to make investment in soil erosion control measures, and society in the sense that it will directly or indirectly pay at least a portion of the costs. Response analysis will evaluate soil erosion control policies with respect to the response to each policy by farmers and response to each policy by extension workers in the Peace River region. A farmer attitude survey has been conducted using an interview questionnaire (Appendix I) to obtain indications of the perceived acceptability of alternative soil erosion control policies. Responses to alternative policies by regional extension workers were also extracted from information gathered through informal interviews in which their perceptions about various policy issues were revealed.

To explore the possible reactions of farmers toward alternative soil erosion control policies, the questionnaire was designed:

1. to determine whether or not farmers perceive the existence of a soil erosion problem;

2. to determine the reasons for using current farming practices that include summerfallow, crop residue removal, and other erosive practices;
3. to determine experiences and attitudes towards soil erosion control practices and available soil conservation information;
4. to determine farmers' perceptions of crop yield risks associated with erosion control practices and soil erosive practices;
5. to determine preferences for alternative financial incentives and other institutional arrangements requiring soil erosion prevention; and
6. to determine the likely rate of adoption of various soil erosion control policies.

After the questionnaire was reviewed by a number of district agriculturists and other extension workers, 18 farmers from the Peace River region were interviewed. The sample for this study was drawn from areas surrounding Grande Prairie (7 farmers), Fairview (6 farmers), and Peace River (5 farmers) on a random basis. Farmers randomly selected in these areas were reasonably expected to reflect all major variations in farming practices, crop yields, economic returns and soil loss magnitudes. The farmers interviewed in each of the three areas were chosen on a randomly sited systematic basis from all listed farmers in respective district agriculturists' offices. The sample size was limited to 18 because of travel distances and lack of research funds. There were serious survey funding impediments. All interviews were conducted during the last week of April 1981. Although the sample is small, it may provide a basis for policy analysis. The farmer attitude survey results are presented in Chapter VII.

Agricultural extension workers and government personnel from other departments, including Alberta Environment and Alberta Municipal Affairs in the region, were interviewed informally in groups and separately during the last week of March 1981. This group (hereinafter referred to as extension personnel) were asked many policy-related questions in order to obtain their reactions to various proposed policies. Their responses have been interpreted without bias and are presented in Chapter VII.

To reduce the extent of soil erosion in the Peace River region, it is important to evaluate existing soil erosion control policies, and if inefficient, identify alternative policies. Existing soil erosion policies and programs to mitigate erosion are corrective rather than preventative in nature. Hence, they are costly, time-consuming, ineffective and unable to alter individual behaviour (Phillips, DePape and Brook 1975). The central issue then becomes one of determining a set of institutional arrangements which influence individual farmer behaviour. An institutional approach which induces behaviour on the part of individuals and consistent with desired performance is discussed in the next chapter.

V. An Institutional Approach to Soil Erosion Problems

This chapter contains an institutional approach to soil erosion problems. The discussion begins with a brief statement on the intellectual roots of the institutional approach followed by a brief sketch of the basic determinants of Commons' policy analysis. The discussion follows with Commons' scheme of authorized, authoritative and authority relationships and a Commons' institutionalism-mainstream economic synthesis. Finally, a conceptual framework is developed using the Commons mainstream economics synthesis to analyze soil erosion control policies. This conceptual framework facilitates an analysis of soil characteristics and farmer behaviour relationships (Chapter VI), an analysis of soil erosion control policies as perceived by farmers and extension workers (Chapter VII), and an extension of the approach to develop soil erosion control policies (Chapter VIII).

A. Roots of the Institutional Approach

The Institutional approach to study economic problems originates from the works of Ely (1889) and is associated with the seminal and pathbreaking works of Commons (1924, 1925, 1931, 1934a, 1934b, 1965) and other more recent scholars (Hobson 1901, Veblen 1904 and 1919, Mitchell 1913, 1914 and 1924, Ranade 1920, Tugwell 1922 and 1924, Clark 1923, 1939 and 1957, Sombart 1929, Lowe 1935, Ayres 1938, 1944 and 1961, Means 1938, Parson 1941 and 1942, Mukerjee

1942, Gruchy 1947 and 1972, Colm 1955, Dorfman 1955 and 1968, Boulding 1957, Galbraith 1958, 1971 and 1973, Myrdal 1958, 1960 and 1978, Ciriacy-Wantrup 1952, Kuznets 1963, Gonce 1971 and 1976, Samuels 1972, Bromley 1976a, Goldberg 1976b, Kelso 1977, Schmid 1978, and Randall 1978a), in that tradition who are extending mainly the basic works of Veblen, Commons and Mitchell. All of these economists have been grouped as institutionalists, neoinstitutionalists, heterodox economists or neoinstitutionalist-heterodox economists. For example, Gruchy (1972) labels the works of Ayres, Galbraith, Lowe and Myrdal as "neoinstitutional economics" to distinguish them from the "old institutional economics" works of Veblen, Commons and Mitchell; whereas Randall (1978a) groups those economists who have antecedents in institutionalists thought, but also work within a neoclassical framework into a school known as "neoinstitutionals". Landreth (1976, p. 319), groups most of the above mentioned economists as dissidents from orthodox economics--"one unquestionably common element". The combined group following Landreth is referred to herein as institutional economists due to their broad approach in dealing with practical and political problems in an effective way.

Among the above mentioned economists, the focus is on Commons and on the transmission of his thoughts reflected in institutional economics research in the last four decades. Commons brought institutional economics to us and applied its concepts to agricultural problems. If one examines the work of many resource and agricultural economists,[29] one may see the reflections of Commons' thoughts in their writings - in some cases being merely an extension of Commons' work and in other cases being an improvement.[30] However, no major attempt has been made to date to interpret Commons' work and link it to mainstream economics. As Boulding (1957, p. 8) concluded, Commons' "theoretical structure remains today exactly where he left it, a tangled jungle of profound insights, culled by an essentially non-theoretical mind from a life rich with experience of economic realities. No disciple has taken it up or even ventured to interpret it for the lay public..., Commons gathers dust on the shelves".

The purpose here is not to extend or modify Commons' legal economic theory (1893, 1907, 1913, 1924) and institutionalism (1931, 1934a, 1934b, 1950); neither is it to provide guidelines to analyze the encyclopaedia of Commons' "tangled jungle of profound insights", nor to respond to the naive question of Seckler (1966, p. 261) who asked, "does Commons have any economic theory aside from his ideas about social reform?"[31] Rather, it is merely an attempt to interpret a few ideas of Commons' institutional and legal theories and to show their capability to deal with the challenging problems in natural resource economics. Much of the current work related to public policy is overly concerned with marginal analysis and/or abstract theoretical models, and suffers from a failure to make use of a broader approach to deal with complexities in such problems as soil erosion and agricultural pollution. By making use of the basic principles of policy analysis which Commons developed a half century ago in his monumental, *Legal Foundations of Capitalism* (1924), *Institutional Economics* (1934a), and *The Economics of Collective Action* (1950), an improvement in the current state of neoclassical theory can be anticipated. The resulting framework can then be utilized to deal with the challenging problems in natural resource economics and other areas of economics.

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[29] See Chapter IV.

[30] For example, Commons' ideas have influenced those researchers who work with the structure-conduct-performance paradigm, end, labour and international development problems (Randall 1978a, p. 5).

[31] For an excellent exposition of Commons' legal and economic theories, see Boulding (1957), Gonce (1971, 1976), Gruchy (1947, 1972), Kanel (1974), Kuznets (1963), Ostrom (1976), Parson (1942) and Goldberg (1976a, 1976b).

B. Determinants of Commons' Policy Analysis

Commons' framework of policy analysis emerges from a background of evolutionism that includes such writers as Comte, Marx, Ward, Ross, and the German historical school (Gonce 1971, p. 83). Commons' foundation of economic theory, which stems from evolutionary sociological theory and theory of law, is basic to an understanding of how he developed the basic determinants of policy analysis. As opposed to classical, Austrian and neoclassical economists who saw a harmony of interest arising through voluntary exchange from the interactions of independent and entirely selfish individuals, Commons saw conflict as the predominant economic phenomenon working from a more complex concept of human motivation and social organization. Commons' policy analysis starts with man and attempts to substitute man's static, individualistic psychology with an evolutionary social psychology. Commons (1965, pp. 7, 18, 35) hypothesized that man is a creature of his environment, an evolutionary product of the struggle to survive by producing and consuming material goods and services. Commons' conception of man, that he is "static, self-interested, purposive, stupid, capricious, ravenous for power, and oppressive unless his will is coerced", leads him to reject the traditional doctrine of natural harmony of interests and makes conflict one of his cardinal tenets (Commons 1934a, pp. 682, 702, 705, 743, 874).

According to Commons (1934a, p. 706), security, liberty and equality are the three most fundamental social conditions individuals want in a society in order to pursue self-realization. These conditions exist because "man craves security for his expectations and could not act at all as a rational being without the feeling of security" (Commons 1924, p. 364). Commons assumes that material scarcity exists. In the face of material scarcity, self-interest breeds conflict and disorders, and conflicts of interest, in turn, then ruin the social conditions (Commons 1934b, pp.97, 98). Impelled by material scarcity and conflicts of interest, man insists on private ownership, which is a person-to-person relationship with respect to property and is based on coercion. Social classes appear among individuals with similar ownership patterns and who collectively pursue common interests. Private ownership does not suppress conflicts of interest because class conflicts then emerge. In Commons' opinion, conflicts of interest breed unorganized and deliberately organized institutions to regulate human behaviour and to provide security, liberty and equality. Thus, institutions resolve conflicts of interest and produce institutionalized individuals, regulate behaviour and secure expectations (Commons 1934b, pp. 97-98; Gonce 1971, p. 84).

Commons (1931, p. 649) defines institutions as "collective action in control, liberation and expansion of individual action". Institutions include laws, constitutions (i.e., "laws about making laws"), traditions, moral and ethical structures, and customary and accepted ways of doing things (Commons 1924, p. 124). Principles of scarcity, efficiency, futurity and working rules of collective action are the common principles applied to unorganized custom as well as to organized going concerns (Commons 1931, p. 650). Commons states that the term "working rules is appropriate to indicate the universal principle of cause, effect or purpose, common to all collective action. ... they indicate what individuals can, must, or may or may not do, enforced by collective sanctions" (Commons 1931, p. 650). Thus, institutions express a society's value system and give it effect in the form of working rules. In other words, institutions or working rules order the relationship among individuals within society.

Taking a clue from Hume, analysis of Commons' collective sanctions provides a correlation among economics, jurisprudence and ethics which is prerequisite to an institutional approach. Commons asserted that "ethics deal with the rules of conduct arising from conflict of interests, arising, in turn, from scarcity and enforced by the moral sanctions of collective economic sanctions of profit or loss in cases of obedience or disobedience, in which jurisprudence deals with the same rules enforced by the organized sanctions of violence" (Commons 1931, p. 650). But the principle of collective action is more universal in the unorganized than in the organized form of institutions (Commons 1931, p. 650). Unorganized institutions include ethical beliefs and customs and these are man's response to changing conditions of scarcity and conflicts of interest. In Commons' view, while unorganized institutions influence human behaviour, they do not exert sufficiently strong sanctions to be deterministic of human behaviour. Commons believes that organized going concerns can induce human behaviour and therefore he develops his analysis upon such concerns. Organized institutions emerge in order to resolve conflicts of interest of many individuals with diverse interests and preferences. To maintain a coordinated flow of action and transactions in the conduct of any going concern, society adopts working rules which define person-to-person relations with respect to property (Gonce 1971, pp. 84, 85).

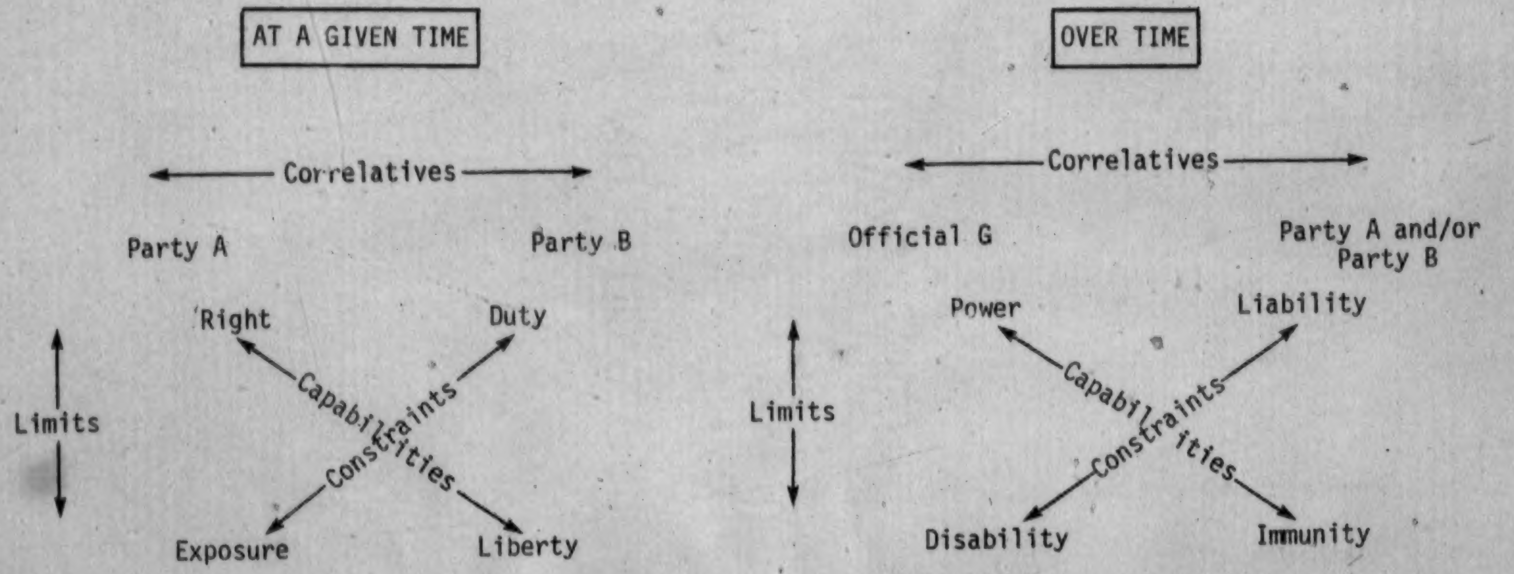
Working rules are arrangements for interdependent decision-making in reciprocal and joint efforts and they enable each individual to relate himself to others in productive efforts. The capacity of individuals to form stable expectations about the behaviour of others by knowing the working rules is a basic condition for the function of any organized going concern. That which Commons calls the principle of working rules is critical to form social relationships and to the choice of alternative policies (Ostrom 1976, p. 841). The basic unit of individual actions is the transaction which involves alienation and aquisition to rights of property and liberty created by society and which therefore must be negotiated between parties concerned before production, consumption and exchange can take place (Commons 1931, p. 652). By establishing and enforcing working rules, the institutional framework makes the transaction feasible by providing the parties with reasonably sure expectations of performance. By enforcing working rules in which institutions limit and control man in his pursuit of his self-interests, two effects are produced: man creates institutions and institutions tend to shape man by influencing his patterns of thought, behaviour and expectations as he reacts to them; and working rules establish a network of social relations specifying agreement about everything with everyone. This network gives form to the structure of society, provides an individual with some secure rights and places some limitations on the actions of others which might impinge upon him (Gonce 1971, p. 85; Randall 1978a, p. 4). In treating the concept of working rules, Commons (1931, p. 654) recognizes that an institutional approach must make an analysis of the behaviour of individuals while they are participating in transactions. Drawing from the ideas of Hohfeld (1913), Commons devised a scheme which allowed the analysis of working rules enforced by all types of institutions. This chapter is now directed to Commons' schema of relations.

C. Commons' Schema of Individual Relations

Commons' concept of working rules is a major contribution to policy analysis. Working from the ideas of Hohfeld (1913), Commons believed that person-to-person relations with respect to scarce goods or property can be analyzed in terms of any or all of eight fundamental relations in the definitional scheme shown in Figure 5.1. Although the basic eight legal terms were given by Commons (1924, pp. 84, 85, 87, 96, 116, 131), Ostrom (1976, p. 843, 844) added the diagonal characterization to indicate that the general structure of authorized and authoritative relationships has reference to both capabilities and constraints. Commons' and Ostrom's explanations are combined in Figure V.1 for better exposition of the working rules.

FIGURE V.1

COMMONS' SCHEMA OF RELATIONS


AT A GIVEN TIME
Correlatives
Party A
Party B
Right
Duty
Limits
Capabilities
Constraints
Exposure
Liberty
OVER TIME
Correlatives
Official G
Party A and/or Party B
Power
Liability
Limits
Capabilities
Constraints
Disability
Immunity

V.1a Authorized Relationships

V.1b Authoritative Relationships

In establishing the concept of working rules, Commons used "words as symbols". He recognized that the systematic arrangements in the formulation of words, determining their application and enforcing relationships in accordance with working rules is imperative if words are to work in ordering human relationships. In characterizing the working rules of organized going concerns, Commons (1924, p. 532) distinguished "authorized transactions" from "authoritative transactions". The former allocates authority to determine, enforce and alter authority relationships (Ostrom 1976, p. 842). According to Commons (1924, p. 87), each term has a separate meaning in the two sets of relationships and is related to other terms by way of jural correlatives and limits. The terms in Figure V.1a apply at a given time in the case of authorized transactions. The terms in Figure V.1b apply in a changing situation in the case of authoritative transactions. Both sets together present a more general structure of Commons' schema. Ostrom (1976, p 843) added the diagonal characteristics to indicate that the general structure of authorized and authoritative relationships have reference both to capabilities and constraints. Ostrom emphasized the addition of diagonal characteristics as "it is in this sense that legislation is the proportioning of inducements by assigning capabilities and constraints to individuals for making decisions in relation to those who occupy interdependent positions and engage in transactions with one another" (1976, p. 843).

In Figure V.1a, the leading term is "right", and it correlates with another person's or party's duty: A "specified right" of party A to act imposes a duty on party B to act in accordance with the right being asserted. However, rights and duties are subject to limits (Commons 1924, pp. 84, 85). The limit of A's right is his "exposure", which provides a "liberty" for B. Thus, A's degree of exposure subtracts from his rights; B's liberty subtracts from his duty. Exposures and liberties are correlative in the same sense as rights and duties. The sum of A's rights and exposures equals the duties and liberties of others.

Authorized relations (Figure V.1a) depends upon authoritative relations because words themselves are not self-formulating, self-determining or self-enforcing. Authoritative relations involve authority to determine, enforce, and alter legal relationships. These are relationships that are identified with government institutional arrangments in society at large. Power is the principle leading term in Figure V.1b and defines the authority to determine, enforce, and alter legal relationships. Officials (G) have powers which place liabilities on citizens (party A and/or party B). The limit of liability is immunity, and the immunity of a citizen provides a disability for the official by limiting his power. None of the eight terms is absolute or infinite; each has its limits as well as its correlatives.

The relationship between two sets of relationships, those between private citizens (authorized relations) and those between private citizens and the state (authoritative relations) are correlative and equivalent in the sense that when the relations between citizens and officials are determined, this determines also the relations among citizens (Commons 1924, pp. 123-124). The very basic assumption is that a right depends upon the availability of remedies to procure enforcement or imposition of sanctions for the failure of a person under duty to perform in accordance with that duty. Futhermore, the assumption correlates two sets of relationships when a person making a claim to a right fails to procure authoritative remedies to enforce that right; the person then stands exposed. Rights in the structure of authorized relationships thus depend upon an equivalent access to power in the structure of authoritative relationships (Ostrom 1976, p. 845).

Powers of individuals which determine the limit of property and liberty, including the limits of defining and enforcing contracts, are the means by which individuals may free themselves of liabilities. It is this concept that Commons (1924, p. 124) uses to represent a complete scheme of legal correlatives, equivalents, limits and reciprocals accompanying every transaction. This concept is reproduced in Figure V.2. Commons (1924, pp. 122, 124) refers to this conceptual apparatus as a "scheme of words and definitions" or a "kind of mental compass" which may be used in

FIGURE V.2

COMMONS' SCHEMA OF AUTHORITY RELATIONSHIPS

← Correlatives and Equivalents →

↑ Limits and Reciprocals ↓

Official	Citizen		Citizen	Official
Power	Right	Opportunity Set	Duty	Liability
Disability	Exposure		Liberty	Immunity
Immunity	Liberty		Exposure	Disability
Liability	Duty		Right	Power

SOURCE: Commons, J.R., The Legal Foundations of Capitalism (New York: Macmillan, 1924): p. 124.

understanding the patterns of interdependencies that arise from structures of institutional arrangements (Ostrom 1976, p. 845). Commons, in structuring this scheme of authority relationships, considered the "behaviour" to which the "reasoning" is applied. The rational relations existing between legal and economic ideas are also considered. Commons believed that his rationalizing scheme, which is a combination of authorized and authoritative relations, has "universal" application (Commons 1924, pp. 47-129).

Commons' (1924, pp. 124-134) mechanism of relationships is examined in the context of a soil erosion problem. The leading terms in Figure V.2 are power and duty. For example, it is the "duty" of an agricultural service officer to serve a written notice to farmer A, who does not hold a license for water diversion, but nevertheless diverts water onto his neighbour's (farmer B) field. The agricultural service officer serves a written notice to farmer A upon hearing about the complaint from farmer B. In order to perform this "duty", the agricultural service officer carries with him the potential "power" of the Agricultural Service Board. To represent the government, an agricultural service officer is treated as the government in action. The government is what its officials do (this representation is consistent with Commons' terminology, to represent the "state" or government, Commons treats officials as the "state-in-action"). An agricultural service officer's exercise of that "power" is "limited" at the point where official disability begins and to the extent that farmer A is legally "immuned". The official is also "liable" for neglect of "duty" or abuse of "power" in ensuring transactions with the Agricultural Service Board. This "liability" of the officer is also "limited" at the point where he can expect "immunity". To that extent an offender (farmer A) is legally "liable". These are but a few abstract relations that surround the agricultural service officer and farmer A, who may be guilty of an offence when they happen to come together.[32] But the actual relations between the agricultural service officer and farmer A is determined by the choice of alternatives which Commons called "discretion". The choice among alternatives is influenced by the "immunity", "liability" or "liberty" that exists and the result of actions taken.

Choice of alternatives helps officials "proportion the behaviour of citizens by offering inducements in the directions which they consider important and away from the directions which they reprobate" (Commons 1924, p. 123). The laws of the state determine the direction of opportunity sets and inducements for citizens. The choice of alternatives determines the limits of the substantive and remedial powers of individual rights in its collective activity, as well as in its limit of the physical power of the government. The substantive and remedial powers are equivalent; when the relations between citizens and officials are determined, the relations among citizens themselves are also determined.

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[32] Compare this example with the example in Chapter IV related to the Coasian solution. In this example rights are subject to limits and working rules govern these rights. In a Coasian example these are "givens" in competitive markets.

Thus, right and duty are assertions of one person's wishes against another person's wishes and which are guided by opinions of right and wrong. The distinction between ethical rights and duties and legal rights and duties is the distinction between two classes of probability respecting human conduct. Commons (1924, p. 127) recognizes that "Law, Ethics and Economics are a different aspect of the same science of probabilities of human behaviour. Law is a science of the probabilities of official transactions in the exercise of authorized physical coercion; Ethics is the science of the probabilities of both official and private transactions; while Economics is a science of the probabilities of official and private transactions in utilizing both human and natural resources for ethical, economic and *public purposes*" (emphasis added). Without including the concept of human purpose and integration of the fields of law, ethics and economics, the establishment of an institutional approach cannot be accomplished. It is the concept of purpose that introduces the concept of "reciprocity into transactions". According to Commons (1924, p. 131), "reciprocity" is the official valuation of the virtues and vices of human beings". The reciprocity is subtracting in nature, for example, reciprocal duty is a subtracting duty deducted from one's liberty and one's exposure is the reciprocal of one's own liberty.

In summary then, Commons' scheme of understanding the patterns of interdependencies that arise from structures of institutional arrangements (working rules), indicates that the concept of correlates and equivalents holds between structures of authorized relations and authoritative relations, and these relations underlie the notion of reciprocity, which is none other than the system of limited rights and duties.

D. Commons' Institutionalism and Mainstream Economics Synthesis

Commons' institutionalism is the outcome of his grand success to convert his vision of law, ethics and economics into the systematic study of the creation, functioning and demise of institutions. Commons' concepts of "institutions", "going concerns", "working rules" and "transactions" provide an approach for a powerful analysis. Commons' institutions express a society's value system and give it effect in the form of making rules. As such, they tend to shape the individual's behaviour, actions and expectations. Man responds positively to institutions he views as ethically right and negatively to those he sees as ethically wrong. The day-to-day transactions of individuals and groups will proceed smoothly when institutions are in harmony and when that is not the case, defiance and perhaps social upheaval and insurrection will result. From this point of view the fundamental task of social science is to design new institutions which must provide more effective avenues for transactions among individuals in order to resolve conflicts (Day 1975, p. 235; Gonce 1976, p. 778; and Randall 1978, p. 12).

Commons' institutionalism is full of profound insights. He has "tried to formulate an analysis which would give a foundation for the coordination of the social sciences, especially law, ethics, economics and political science" (Parson 1942, p. 260). Due to his uncompromising belief in evaluationism, rationalism and multiple causation, he proposes to treat all factors influencing transactions as endogenous interdependent variables. For this reason, according to mainstream economists, Commons' model is not especially amenable to the production of testable hypothesis. Commons responds to this criticism in two ways. He proposes that, "indeed, a science is not a body of knowledge - it is just a method of investigation, and its theory is its method" (1934a, p. 722). On the basis of this proposition, he argues that the meaning of economic science must lie in its procedure (method), rather than in its substance (theory). Secondly, he proposed a scheme to regulate economic behaviour which is a function of five groups of interdependent variables: futurity, scarcity, efficiency, custom and sovereignty (Commons 1934a, pp. 77, 719-748). As Randall (1978b, p. 286) comments, "Commons' system was a detailed, and in many ways, valid description of the real world. As a model, it failed to find favour with mainstream economists, not because it was wrong--it wasn't--but because it was not well adopted to the analytical technology of the economists of its day, geometry, algebra, and calculus." Commons suggested that his institutionalism is in no way an alternative to mainstream economics, but should be treated as a complement in order to produce a better economic framework (Commons 1931, p. 648). For example, he proposes to use empiricism, multivariate analysis, and statistical techniques to investigate the relevant variables and formulate them into economic theory (Gonce 1971, p. 88; Gruchy 1940, pp. 823-49).There could be no clearer evidence of Commons' ideas about his institutionalism and mainstream synthesis. The failure of the mainstream economists to understand this aspect seriously undermines Commons' analysis.

If mainstream economics can complement Commons' institutionalism, the resulting product would be distinguishable from, and superior to, existing neoclassical formulation. Over the course of the last two decades or so, scholars who identified with institutional economics, public choice and social choice theory, political theory, property rights and environmental economics have been generating a substantial volume of literature with logical implications following various ideas contained in Commons' *Legal Foundations of Capitalism, Institutional Economics and*

Economics of Collective Actions. For example, the logic of constitutional choice developed by Ostrom (1971) provides a conceptual apparatus and terminology that complements Commons' idea of correlates and equivalents which hold between structures of authorized relations and authoritative relations. With Commons' basic idea that it is individuals who reach decisions about the rules that apply to decisions in a collectivity, Ostrom constructed the general theory of constitutional choice. Commons' ideas were most influential among the economists who work with the structure-conduct-performance paradigm. These economists related only Commons' ideas of human behaviour and working rules to the paradigm. Schmid (1972, 1978), Seitz, et al. (1978) and Sharp and Bromley (1979a) undertook this task but unfortunately (except in Schmid, 1978), they developed their analyses around the structure-conduct-behaviour model only. Commons sought to develop a synthesis of institutionalism-mainstream economics which would result in a system of institutional analysis capable of conceptualizing the pursuit of strategies in concurrent structures. This focus is the kind of analysis used herein to analyze soil erosion problems.

E. Institutional Analysis of Soil Erosion Problems

In order to analyze soil erosion problems within Commons' conceptual framework, it is important to view the applicability of determinants of Commons' policy analysis to the soil loss problem. As mentioned earlier (Chapter IV), farmers in the Peace River region are experiencing pronounced soil loss. Soil losses from water induced erosion in the region may be attributed to soil characteristics, farmers' perceptions of current soil use, farming practices and existing soil erosion control policies. The farm level damages associated with soil erosion include loss of productive soil, crop productivity, as well as temporal and spatial damages. The nature of private landownership does not take into account society's values. Existing government soil erosion policies and programs are corrective (rather than preventative) in nature, time-consuming, ineffective and unable to alter individual behaviour sufficiently to mitigate erosion (Phillips, DePape and Brook 1976). Also, the current institutional arrangements do not include a wide ranging opportunity set to induce altered farm operator behaviour. The central issue then becomes one of determining a set of institutional arrangements which influence individual farmer behaviour as well as government agency behaviour.

As Commons' proposed, since "the behaviour in question is none other than the behaviour of individuals while participating in transactions, institutional economics must make an analysis of the economic behaviour of individuals" (Commons 1931, p. 654). The loss of productive scarce soil in the Peace River region is the result of "static" and "self-interest" behaviour by farm operators who enjoy the liberty of private landownership. Self-interest behaviour coupled with private landownership creates conflict and disorder among farm operators, among farm operators and non-operators and between present and future generations. Alternative institutional arrangements or modificatons of existing institutional arrangements may resolve spatial and temporal conflicts and produce institutionalized individuals and regularities in behaviour. Only organized institutions can reliably create regularities in farm operator and government agency behaviour, since these institutions adopt working rules which define person-to-person relationships with respect to landownership. Organized institutions, as opposed to unorganized ones, exert sufficiently strong sanctions to affect both farmers' behaviour and government officials' behaviour. Commons' schema of relations (Figures V.1 and V.2) provides input for such an analysis.

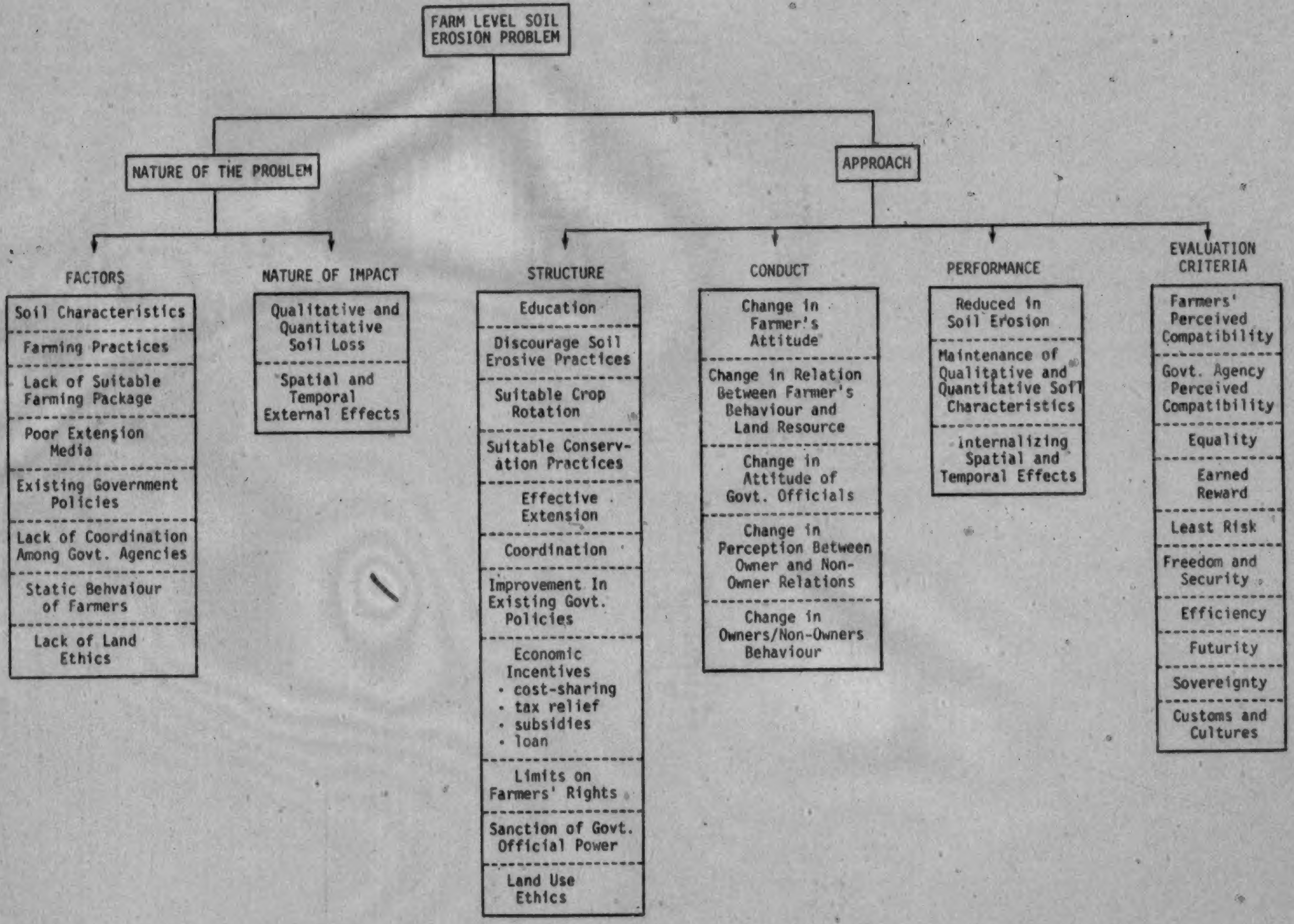
Regularities in economic behaviour or transactions are a function of five groups of interdependent variables: futurity, scarcity, efficiency, custom and sovereignty. Commons' ideas are translated into a policy analysis framework. Policy analysis requires three fundamental elements, namely structure, conduct and performance. This concept is adopted by Schmid (1972), Seitz et al. (1978) and Sharp and Bromley (1979a) to provide analytical frameworks for natural resource problems. Although the structure-conduct-performance model has its roots in market research, it is highly influenced by Commons' ideas (Randall

1978a, p. 12). Without incorporating Commons' ideas to the orthodox structure-conduct-performance model, the model's capability to analyze natural resource problems can be seriously questioned. In Commons' terminology, structure refers to the identification of institutional alternatives or working rules; conduct refers to person-to-person relations; behaviour and action of "citizen" and "official" performance are in terms of various intermediate products; and finally, individual quality of life. In Commons' treatment of structure, he makes a basic distinction between the "going concern" and the "plant". The plant (production activities) results in a flow of events which have increased activity levels over previous production levels. By contrast, the going concern involves the flow of human actions and transactions that mediate and guide the flow of events. This distinction of Commons is based on his more basic distinction between materials and person-to-person relations (or "ownership"). This distinction also identifies non-institutional considerations as opposed to institutional ones in human action. Thus, Commons' concept of structure in the structure-conduct-performance model refers to person-to-person relations (ownership) rather than, say, price variables in the context of the conventional structure concept. In other words, Commons' structure is related to the institutional arrangements which deal with regularities in economic behaviour or transactions. The flow of human actions and transactions involves the conduct or behaviour of many individuals with diverse interests and preferences who now function collectively to produce a stream of goods and services. Maintaining a collective flow of actions and transactions in the conduct of any going concern depends upon working rules that enable each individual to relate himself to others in productive efforts. The operation of any going concern depends also upon the capability of individuals to form stable expectations about behaviour of others by knowing the working rules (Commons 1924, pp. 322-325; Ostrom 1976, pp. 841-842). Turning to performance, Commons' concern is with the institutionalized behaviour of the individual. The structure-conduct-performance model for analyzing soil erosion problems is now proposed which involves a major conceptual framework derived from Commons' institutional economics.

Figure V.3 shows the factors and nature of impacts of the farm level soil erosion problem and an approach to develop soil erosion control policies. As the figure indicates, the soil erosion problem can be attributed to soil type or soil characteristics, farming practices, farmers' perception and government policies. The nature of impact is both qualitative and quantitative soil loss in spatial and temporal dimensions. Among all factors affecting soil erosion, the farmer's perception towards land use in the Peace River region is most attributive. When the problems have been identified, it is necessary to determine whether or not the current institutional arrangements are

FIGURE V.3

SCHEMATIC FOR ANALYZING SOIL EROSION PROBLEMS AND FORMULATION OF POLICIES TO CONTROL FARM LEVEL EROSION


FARM LEVEL SOIL EROSION PROBLEM
NATURE OF THE PROBLEM
APPROACH
FACTORS
Soil Characteristics
Farming Practices
Lack of Suitable Farming Package
Poor Extension Media
Existing Government Policies
Lack of Coordination Among Govt. Agencies
Static Behvaiour of Farmers
Lack of Land Ethics
NATURE OF IMPACT
Qualitative and Quantitative Soil Loss
Spatial and Temporal External Effects
STRUCTURE
Education
Discourage Soil Erosive Practices
Suitable Crop Rotation
Suitable Conservation Practices
Effective Extension
Coordination
Improvement In Existing Govt. Policies
Economic Incentives
· cost-sharing
· tax relief
· subsidies
· loan
Limits on Farmers' Rights
Sanction of Govt. Official Power
Land Use Ethics
CONDUCT
Change in Farmer's Attitude
Change in Relation Between Farmer's Behaviour and Land Resource
Change in Attitude of Govt. Officials
Change in Perception Between Owner and Non-Owner Relations
Change in Owners/Non-Owners Behaviour
PERFORMANCE
Reduced in Soil Erosion
Maintenance of Qualitative and Quantitative Soil Characteristics
internalizing Spatial and Temporal Effects
EVALUATION CRITERIA
Farmers' Perceived Compatibility
Govt. Agency Perceived Compatibility
Equality
Earned Reward
Least Risk
Freedom and Security
Efficiency
Futurity
Sovereignty
Customs and Cultures

capable of inducing conservation behaviour. Since the level of performance of the current institutional arrangements relating to soil erosion control is not satisfactory (Phillips, DePape and Brook 1975), the policy reformulation process becomes a vital activity. To influence the behaviour of a farmer, the proposed scheme in Figure V.3 has a wide range of institutional arrangements. The basic policy approaches to be used in the development of alternatives are education, economic incentives, legislation and direct investments. Furthermore, within each of these approaches there are numerous alternatives which will have greatly different impacts on the soil erosion control and on the performance of the policy in meeting the social goal.

Working rules restrict individual freedom by limiting the harm that an individual can impose on others and enhancing the freedom of individuals by ensuring protection from harm done by others. In the Peace River region. the individual farm operator under the private landownership may be slowly mining his own valuable soil resource and thus imposing a cost on farm operations quite aside from these spatial and temporal damages. The problem is one of searching for a set of working rules or institutional arrangements that (1) impose minimum cost on those whose current behaviour or action requires modification; or (2) provide financial incentives to induce behaviour which is consistent with desired results from a social point of view. The modified or altered behaviour would lead to improved performance (less soil erosion) due to a new set of institutional arrangements. As an illustration, currently in the Peace River region, cost-sharing arrangements are only for the construction of grassed waterways. Consider a case in which cost-sharing arrangments for production costs were applied to all of the soil erosion control practices along with the provision of technical advice. This new arrangement alters the relative benefits and cost of prevailing practices and so renders new behaviour which is more attractive to individual farmers. As working rules change, so do institutional arrangment costs. These costs are administrative costs incurred on various government operations to fulfill working rules. Short-run and long-run performances of alternative institutional arrangements are assessed on the basis of the various criteria given in Figure V.3.

Since the conventional performance criteria are not satisfactory (if used as such) because they are abstract, a value judgement, together with Commons' ethical values concept, is also used to broaden the scope of these criteria. Incorporating Commons' interdependent variables (security, equity, liberty and material abundance) should result in the provision of a better criteria formulation to evaluate the conduct of farm operators, and consequently, the performance of the proposed institutional arrangements.

The approach outlined in Figure V.3 will be used to analyze soil characteristics and farmer behaviour relationship (Chapter VI), farmers' and management agency officials' perception (Chapter VII), and developing the soil erosion policies (Chapter VIII).

VI. Soil Characteristics-Farmer Behaviour Model

This chapter analyzes the qualitative and quantitative soil characteristics within Lancaster's "Goods Characteristics Approach" (Lancaster 1966a, 1966b) and is supplemented with institutional arrangements. Section A defines soil as a consumption activity and soil characteristics as outputs. In Section B, Lancaster's 'Goods and Characteristics" are discussed. Section C deals with model specification and Section D contains an analysis of the model.

A. Soil as a Consumption Activity

Soil deterioration has always been a problem in Peace River agriculture due to unique soil characteristics and because the maintenance of soil productivity is essential for sustained agricultural activities. Many of the prime agricultural soils in the Peace River region were formed on lacustrine silts and clays deposited in a glacial lake that covered this area during glacial retreat. The high clay content of these soils slows moisture infiltration which results in excessive runoff. In addition, these fine textured soils lie on long gentle slopes which allow accumulations of large volumes of water resulting in serious water induced soil erosion. More than 50 percent of the cultivated land in the Peace River region contains impervious subsoil due to its high clay content, cultivation depth and the presence of sodium and magnesium salts. The restricted downward penetration of water results in excessive runoff and topsoil erosion. In many locations of the Peace River region, organic matter levels in the soils have been depleted or are naturally low as in the case of Grey Wooded soils. These soils tend to crust or puddle easily thus restricting the infiltration of rainfall or spring snowmelt and render the soil susceptible to erosion (Albeta Institute of Agrologists 1976).

The inherent soil characteristics, that is, low level of organic matter and shallow topsoil depth, combined with soil erosion have threatened the productive capability of the basic soil resource. Soil organic matter is (1) the main natural source of available plant food; (2) an important ingredient in moisture holding capacity; (3) a contributor to water and wind induced erosion reduction and prevention; and (4) an important ingredient for improved physical properties. Thus, the level of organic matter is a good indicator of soil resource resilience. The shallow depth of topsoil (10-15 cm.) in the Peace River region has a low level of organic matter (3-4 percent). Thus, the soil's ability to resist erosive forces from surface runoff is low. In short, water induced soil erosion in the Peace River region certainly poses a threat to the basic characteristics and productivity of the soil resource.

Soils in the Peace River region may have many other characteristics, but soil depth and organic matter content are more directly affected by erosion and, at the same time, generally reflect the soil mantle potential productivity. Hence, the soil resource is being viewed as a consumption activity (single input) into a process of soil formation in which soil characteristics (or bundle of characteristics) are the outputs or products. The farm operator as a rational consumer of the soil resource applies farming practices such as intensive fertilizer use and various soil management practices designed to maintain or attain desired quantitative and qualitative characteristics or bundle of characteristics. Soil resource consumption is subject to a farmer's own peculiar set of circumstances that determines soil use rates. The farmer's demand for the soil resource arises from the very basic fact that soils are required to obtain characteristics and soil characteristics are needed to perform agriculture activities. This situation is analogous to Lancaster's (1966a, p. 14) *New Approach to Consumer Theory* where "the consumer's demand for goods arises from the fact that goods are required to obtain *characteristics* and is a *derived demand*" (emphasis added). Lancaster's consumer has a single consumer activity (input) and a bundle of characteristics or joint outputs. The farm operator has a similar package also--soil as an economic resource and joint output or a bundle of characteristics in the form of topsoil depth, organic matter and many other soil properties. At this point, Lancaster's approach deserves a brief description.

B. Lancaster's Goods and Characteristics Approach

Lancaster's new approach to consumer theory is the outcome of his frustration with the then current status of consumer theory.[33] According to Lancaster, traditional consumer theory does not offer a satisfactory account of three fundamental issues: (i) the introduction of new goods or changes in the quality of existing commodities; (ii) the closer substitution of some goods in consumption than others; and (iii) the absence of purchase of some goods and the grouping together of others. Traditional theory says nothing about these issues, particularly in cases of consumers' reactions to new commodities or quality changes. The only response of the traditional consumer theory to these issues is "this is the way the consumer's preference ordering is" (Green 1976, p. 157). Lancaster suggests that these problems can be lessened using a characteristics approach where the elements of the set of alternatives on which the consumer's preference ordering is defined are regarded as bundles of characteristics of goods rather than as bundles of goods *per se*. Lancaster describes his new approach as follows: "the chief technical novelty lies in breaking away from the traditional approach that goods are the direct objects of utility and, instead, supposing that it is the properties or characteristics of goods from which utility is derived. We assume that consumption is an activity in which goods, singly or in combination, are inputs and in which the output is a collection of characteristics" (1966a, p. 133). He further emphasized that "the jointness of the characteristics is really the core of the whole approach" (1966b, p. 15).

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[33] For a critical summary of the current state of the theory of consumer behaviour, see Johnson (1958) and for successive improvements in traditional consumer theory, see Morishima (1959), Pearce (1964) and Samuelson (1948). For further details of Lancaster's approach beyond that described herein, see Lancaster, (1966a, pp. 132-157; 1966b, pp. 14-23).

In essence then, the new approach to consumer theory suggests that it is the characteristics rather than the goods that give rise to utility. A single good (input) may have more than one characteristic and many characteristics may be shown by more than one good. Goods in combination may have quantitative and qualitative characteristics that differ from those pertaining to the individual goods separately (Lancaster 1966a, p. 134). Thus, for example, different soil types may have many characteristics: depth of topsoil, level of organic material, plant nutrients and soil structure. These characteristics may be common in many major soil groups but in qualitatively and quantitatively different combinations (refer Chapter IV, Section C). It is this idea of Lancaster's approach which provides the basis for the construction of a soil characteristics model.

If Lancaster's new approach to consumer theory is combined with the institutional approach (refer Chapter IV), the outcome will provide us with a soil characteristics-farmer behaviour model (SCFBM). The institutional arrangements can motivate farmers to invest in soil resources in such forms as fertilizer applications and good tillage practices, in order to increase the level of organic matter and maintain other topsoil properties including depth, which ultimately bring about some degree of correspondence between the actions of farm operators and the interests of society. To this end, this research proposes to develop a soil characteristics-farmer behaviour model which allows a conceptual analysis of soil characteristics and soil use rates and an accounting of the institutional structure or working rules which may generate or regulate specified kinds of farmers' behaviour conducive to these characteristics.

C. Model Specification

Water induced soil erosion is a serious problem in the Peace River region. Many soil characteristics associated with the basic soil resource are affected by this erosion, particularly the two basic soil characteristics or variables, namely organic matter in the top 12.7 centimeters of soil and topsoil depth.[34] Because most of the Peace River soils are relatively homogenous in their profile below the topsoil, these two soil characteristics or variables allow a simplified conceptual delineation of the losses of productive soils in terms of quality (organic matter) and quantity (depth). For a given soil, topsoil depth and organic matter taken jointly reflect soil fertility and soil structure over time quite well, if management practices and incentives are also taken explicitly into account in the soil characteristics model. While soil fertility and soil structure generally vary across locations due to basic parent material, this variation is not significant here. Although it is important to recognize that organic matter and topsoil depth change over time, this change takes place very slowly. Consequently it is plausible to assume that the soil is a stock of nutrients and organic matter that is available for the production of food and fibre at any given time. It is a meaningful assumption because the soil renewal factor from a substrata is near zero.

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[34] Burt (1981, 9. 84) also used topsoil and organic matter as explanatory variables in a dynamic optimization model.

The rate at which the soil is renewed or depleted depends on soil erosion control practices that are introduced by socio-economic incentives or an institutional structure. The working rules or institutional arrangments include farming practices, crop rotations, investments in soil erosion control practices, and proper financial incentives which jointly affect soil organic matter and topsoil loss through erosion and net cash flow from the soil resource. The incentives offered through soil erosion control policies or programs are aimed at lowering the costs of conservation to the individual landowner. In so doing, society is attempting to maintain or improve the social capital embodied in the soil resource. For example, in order to maintain a good soil aggregate, the soil organic matter supply must be renewed frequently. Unless a continuous supply of organic matter is available to serve as a supply of cemented agents, the soil aggregate will become unstable and break down. Therefore, it is essential that a continuous supply of crop and/or animal residues be returned to the soil. Unless a Peace River farm operator maintains sufficient sources of organic matter and, at the same time, discontinues summerfallowing, crop residue removal and other erosive practices, soil erosion will continue to deteriorate the Peace River soils.

Many Peace River farmers continue to mine the soil by employing erosive farming practices which currently offer high yields, but because of cumulative soil erosion, diminish the future productivity of soil. Perhaps one reason of adopting erosive farming practices is that many conservation practices appear to be more costly than erosive practices, at least from a short-run perspective and the farmer has generally no interest in bearing the additional cost associated with conservation practices. Cost of not adopting conservation practices becomes a benefit in the form of yield damage and soil loss avoided if soil conservation practices are implemented. The short-run perception of the farmer toward soil resource use can be changed through institutional arrangements. Proper financial incentives coupled with educational programs and technical assistance, could alter the farmer's behaviour. The altered behaviour would be consistent with desired performance (policy objectives). With the expectation that altered behaviour would lead to desired performance (less soil loss or improved qualitative and quantitative characteristics), it is important to identify a wide range of institutional arrangements.[35] For example, what improvements in fertility and productive levels through improvements in the basic soil characteristics would take place if cost-sharing arrangements apply to all soil erosion preventative measures rather than grass waterways alone, as is the current practice? To portray such responses, Schmid (1972), Schultz (1968) and Sharp and Bromley (1979a) all suggest that incentives should be concerned with the sensitivity of farm operators' input demand functions. This concept will be used to supplement Lancaster's characteristics approach in order to analyze the soil characteristics-farmer behaviour model (SCFBM).

Let us consider soil types A, B and C. These three soils supply two characteristics: organic matter (m) in percent in the topsoil, and topsoil depth (d) in centimeters. Characteristics m and d are supplied by soil types A, B and C in different amounts. The types of soil are always greater than the number of characteristics. There may well be several combinations of soils, developed on the same kind of parent materials, which give rise to the same bundle of characteristics. This fact is also analoguous to Lancaster's working hypothesis of the goods-characteristics approach (Lancaster 1966b, pp. 15-16). Each soil's capacity to resist erosion depends on the richness of soil characteristics. To illustrate, assume that soil type A has 3.00 percent organic matter and 12.7 centimeters of topsoil, soil B has 1.50 percent organic matter and 12.7 centimeters of topsoil, and soil type C has 2.75 percent organic matter and 7.62 centimeters of topsoil (these figures are within the range of soil profile thicknesses in the Peace River area). Suppose that currently all three types of soils are subject to erosive farming practices, including summerfallowing and crop residue removal. Suppose the incentives offered to encourage soil erosion control practices by policy makers result in altered behaviour of farmers such that they adopt soil erosion control practices and a higher level or richness of the characteristics results. The soil characteristics (m and d) will remain the same but in different amounts in each type of soil. The new levels of characteristics can be regarded as A', B' and C'. Assume that a farmer's budget is X dollars with erosive farming practices and increases to X' dollars with the adoption of erosion control practices. This increased cost may, in part, be shared by the public.

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[35] The structure-conduct-performance model is constructed in a market performance model by Schmid (1972, pp. 893-901). This model was further used by Sharp and Bromley (1979a, pp. 591-600) in the case of nonpoint source of pollution within the production function framework.

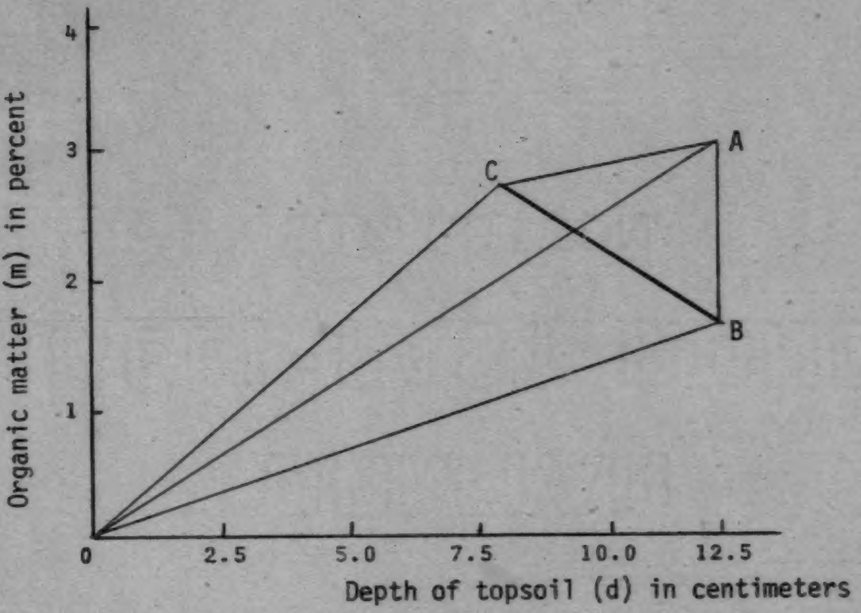
Since institutional arrangements change very slowly over time due to adjustment lags in adopting new policies and programs within a changing environment, so will changes in the levels of the basic soil resource characteristics. The soil characteristic variables and institutional arrangements or decision variables are consistently linked in nature. This assumption underlies the dynamic nature of the model implicitly, although soil characteristics are considered at a given time period. A final assumption is made that each soil category is considered separately. Having specified the model, the discussion now turns to an analysis of the model.

D. Analysis of the Model

The common soil characteristics, organic matter (m) and topsoil depth (d), provide a basis on which to relate soil types A, B and C. The various levels of m and d for the three different types of soil are labelled through rays A, B and C in Figure VI.1. Points A, B and C represent the combinations of m and d for a particular soil at a particular site. Suppose a Peace River farmer has all three types of soil on his farm and the specified combinations of m and d are attainable under current farming practices if the farmer spends his budget (X) on the three soil types, thus attaining given bundles of m and d represented by the lines CA, AB and CB by combining C with A, A with B and C with B respectively. As higher combinations of m and d for each soil type are attained, the farmer reduces current soil erosive farming practices and the frontier CAB is not an efficient one. This frontier only reflects private benefit

FIGURE VI.1

SOIL CHARACTERISTICS AND PRIVATE EFFICIENCY FRONTIER

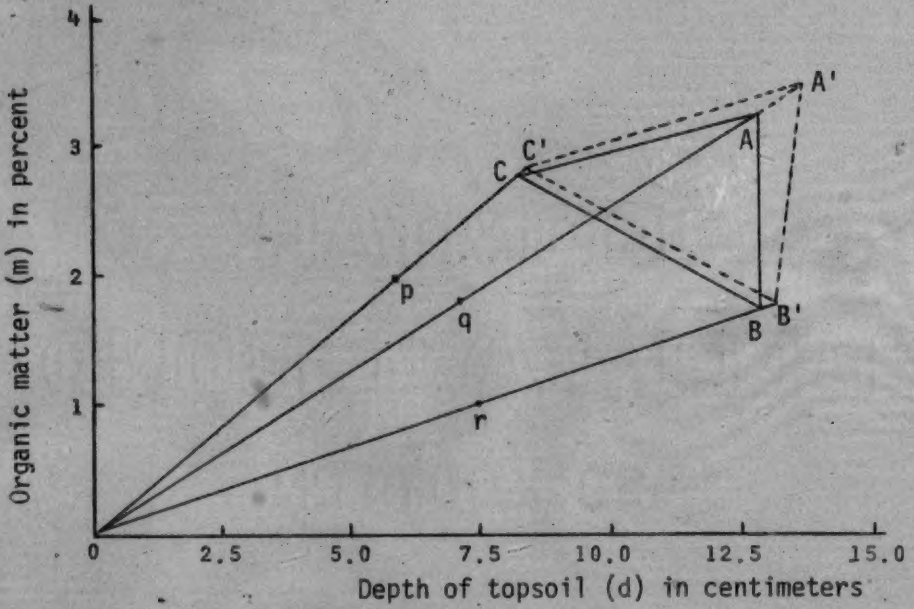

4
3
2
1
0
2.5
5.0
7.5
10.0
12.5
Organic matter (m) in percent
Depth of topsoil (d) in centimeters
A
B
C

and ignores the social benefits. Thus each soil type under existing crop rotations and conservation practices results in poor quality crops and yields, as well as deteriorated soil quality and quantity in terms of organic matter and topsoil depth. If proper crop rotations and soil erosion control practices are provided with appropriate financial incentives to farmers, higher combinations of soil characteristics can be achieved over time.

Now consider the financial incentives and technical assistance offered through soil erosion control programs to farmers, whereby they will adopt soil erosion control practices and thus improve the basic soil structure in terms of soil characteristics. Erosion control practices give rise to the amount of organic matter and topsoil depth in levels represented by C′, B′ and A′ (Figure VI.2). The higher combinations of soil characteristics for each soil type will determine the amount of additional money a farmer has to invest to attain the new set of characteristics. However, if the farmer's share of the investment is made sufficiently low through, say a cost-sharing arrangement, the new set of characteristics in various proportions presented by A′, B′ and C′ can be achieved. The budget will be X′. The cost-sharing arrangement is introduced through input cost-sharing involving say fertilizer, conservation practices, and tillage systems. In the new situation, the farmer now has higher levels of characteristics in all soil types. The quality of the soil resource is changed through

FIGURE VI.2

SOIL CHARACTERISTICS AND SOCIAL EFFICIENCY FRONTIER



the achievement of the new set of characteristic levels, though slowly, using financial incentives. Thus a farmer has all three types of soil, A′, B′ and C′ at his farm which form his efficiency frontier. In the absence of financial incentives, the efficiency frontier may shift to the lower points on the characteristics rays, say p, q, and r. Thus without proper incentives (in terms of policy objectives), a farmer makes private choices which result in the frontier ABC, whereas with the incentives, his efficiency frontier is A′B′C′, which is consistent with the expectations of the society. This shift in the frontier depends on new low cost innovation in terms of soil erosion control practices and soil conservation education. The shift in the frontier also suggests that some farmers are willing to pay for technical information on soil conservation practices, which assists them in maintaining their soils through attaining higher characteristics levels.

Two important policy implications emerge from this soil characteristics-farmer behaviour model. First, soil characteristics′ richness can be changed over time slowly through proper incentives and technical assistance. This quality change in the soil resource provides a stable and strong agricultural base from society′s point of view. Second, this model provides both quantitative and qualitative analyses of the soil resource which are necessary for soil conservation programs.

VII. Empirical Results

Policy-makers need to consider an array of economic, social, legal, political and institutional issues in selecting the most effective feasible soil erosion control policies at the farm level. The ultimate success of these policies depends upon their acceptability by farmers who have to change farming practices or make investments in soil control practices, and by society, which pays a portion of conservation costs coming from public revenues. This chapter contains an examination of farmer and extension worker responses to several erosion control policies in the Peace River region. However, general public attitudes are not examined. On the basis of the public hearings on erosion of land in the Peace River region (Environment Conservation Authority 1976, pp. 13-16), favourable community interest in the prevention of soil erosion may be assumed. Furthermore, it is rational to assume that because individual farmers and extension workers act within a social milieu, they take account of the interdependent interests and actions of many individuals. Hence their responses to a proposed policy may be considered a fair reflection of society's view in the area.

The first section of this chapter outlines briefly the current legislative acts and major forms of financial assistance that could play a role in farm level soil erosion control. The second section presents the results of the sample survey conducted among Peace River farmers. Farmers' beliefs on soil erosion questions and their experiences concerning existing soil erosion control policies, such as cost-sharing, are examined to obtain an indication of the perceived acceptability of selected soil erosion policies. The final section is devoted to an analysis of extension workers' responses to various policy issues.

A. Legislative Acts and Incentive Programs

Recognizing that the erosion problems in Alberta are closely associated with agricultural land use, the provincial government introduced legislation[36] including The Soil Conservation Act, The Agricultural Service Board Act, The Water Resources Act, The Public Highways Development Act and The Municipal Government Act.[37] These Acts require agricultural landowners and government agencies to prevent soil deterioration upon the land by wind or water or by any other cause. Most of these pieces of legislation emphasize corrective measures for erosion control rather than preventative measures. Several agencies (Departments of Municipal Affairs, Transportation, Agriculture and Environment, as well as the Alberta Development Corporation) are responsible for the control of erosion on privately owned lands in the Peace River region of Alberta. A municipal council, through Alberta Agriculture and/or Alberta Environment, may apply for cost-sharing funds in instances where an erosion control project involves water diversion, and would benefit three or more individual landowners. Such funding is available only to meet construction costs of the project work related to water management or grass waterways. Alberta Agriculture shares the costs with the municipality on a 60/40 basis, whereas the Water Resource Management Division of Alberta Environment shares costs with a municipality on a 50/50 basis. Farmers contribute a share (20 to 30 percent) in terms of labour and kind. Thus, financial incentives to control soil erosion are very limited and not available for practices that help maintain the productive capacity of Peace River agriculture by reducing the loss of agricultural soil. Furthermore, establishing cost-sharing arrangements is time-consuming, ineffective and involves frustrating technical complexities (Phillips, DePape and Brook 1975).

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[36] Legislative Acts and incentive programs are discussed in detail in Chapter VIII.

[37] See Appendix II.

B. Farmer Attitudes and Experiences

First-hand knowledge from the field is a prerequisite for a study such as this one. The purpose of the farmer attitude and experience survey was to examine farmers' experience concerning current soil erosion control policies and institutional arrangements, and to explore the probable reactions of farmers, as inferred from their attitudes, to several proposed policies. To provide such information, some general characteristics of the sample farms is presented first, followed by a discussion of survey results.

B.1. General Characteristics of the Sample Farms

Information obtained from a farmer attitude survey related to the various characteristics of sample farms is presented in Table VII.1. Although most of the characteristics are self-explanatory in nature, some deserve elaboration. Summerfallow covers about 20 percent of the total cultivated area and is included in most crop rotations practiced on the sample farms. To perform various conservation practices, such as contouring, cross-cultivation, up and down cultivation and trash cover, farmers use disc type implements, chisel plows and field cultivators. Disc type implements are effective in burying trash and in herbicide incorporation. However, in some situations they cause excessive soil structure disturbance. Chisel plows and field cultivators disturb the soil structure least and effectively retain trash cover on the soil surface. However, minimum tillage seems to be the best choice as the topsoil depth in the Peace River region is generally very shallow. However, a systematic agronomic research attempt is required to make a rational choice with respect to tillage systems in the Peace River region. In addition to summerfallowing, a few sample farms from each of the three farm organization categories also practiced stubble burning. Both practices seriously affect soil productivity.

Most of the sample farms raise both grain and livestock and the larger proportions of sample farmers are full time

TABLE VII.1

GENERAL CHARACTERISTICS OF SAMPLE FARMS

Farm Organization	Number of Farms	Age of Farmer (years)		Nature of Farming		Type of Farming		Land Utilization (Hectares)							Summerfallow as % of Cultivated area	Crop Rotations	Tillage Systems	Conservation Practices
		Between						Farm Area		Average Farm Size	Cultivated Area		Av. Cult. Area Per Farm	Area Under Crops Per Farm				
		30-40	40-50	FT	PT	CP	MP	Owned Per Farm	Leased Per Farm		Owned Per Farm	Leased Per Farm						
Sole Ownership	6	4	2-	5	1	1	5	344.00	43.16	387.16	300.15	29.03	329.15	329.15	26.84	G-W-B-R W-B-R-F F-W-B-R	DT	CO CC SB
Family Ownership	8	3	5	8	-	7	1	505.77	46.03	551.80	379.15	45.02	424.17	420.38	15.80	B-W-F-G F-R-W-B-G R-B-W-F F-R-W-B-B	DT MT	UD CO CC SB
Partnership With Family Members	4	4	-	4	-	2	2	593.90	79.92	673.82	399.43	30.35	429.78	360.18	13.20	G-W-B-R B-R-O-L-G F-R-B-G	DT Disc	CO CC CO(T) SB UD
All Farms	18	11	7	17	1	10	8	471.43	52.61	524.04	357.32	36.42	393.74	376.60	19.97	--	--	--

Notations: FT = full-time, PT = part-time, CP = crop production, MP = crop production + livestock, G = grass, W = wheat, B = barley, R = rape, F = summerfallow, O = oats, L = legumes, DT = deep-tillage, MT = minimum tillage, Disc = discing tillage, CO = contouring, CC = cross-cultivation, SB = stubble burning, UD = up and down cultivation, CO(T) = contouring and trash cultivation.

farmers. A higher proportion of owned farm area (and hence a lower proportion of leased area), characterizes most of the sample farms.[38] This breakdown implies that land transactions generally do not have unfavorable consequences for soil erosion control policies in the Peace River region.

B.2. Results of Farmers' Response

To analyze farmers' perceptions of soil erosion problems, some general information derived from the survey about the respondents' beliefs, awareness of problems and farming practices is required and presented here along with a discussion of the survey results for current soil erosion policies and proposed alternative policies.

Table VII.2 presents farmers' perceptions of several issues that indicate general attitudes toward soil erosion control. It is important to note that 94.4 percent and 83.4 percent respectively, responded with a clear "yes" to the existence and seriousness of soil erosion problems. Table VIII.2 also shows that sheet and rill erosion are of particular concern to a large proportion of farmers. About 44 percent and 17 percent of farmers are also suffering from gully and wind erosion respectively. In farmers' opinions, the most damaging factors contributing to soil erosion problems are soil type, long slopes (topography), spring runoff/snowmelt and drainage disruption due to road

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[38] This is true also for all farms in the Peace River region (see Chapter II).

TABLE VII.2

FARMERS' PERCEPTIONS OF EXISTING SOIL EROSION PROBLEMS

Questions	Yes	No	Don't Know
	- percent -		
1. Do you perceive the existence of a soil erosion problem on your farm?	94.4	5.6	-
2. Do you think erosion is a severe problem on your farm?	83.4	16.6	-
3. Do you have sheet/rill erosion on your farm?	94.4	5.6	-
4. Do you have gulley erosion on your farm?	44.4	55.6	-
5. Do you have wind erosion on your farm?	16.6	83.4	-
6. Is soil type affecting erosion on your farm?	94.4	5.6	-
7. Is topography affecting erosion on your farm?	94.4	5.6	-
8. Is spring runoff/snow melting affecting erosion on your farm?	94.4	5.6	-
9. Is road construction/drainage ditch affecting erosion on your farm?	66.6	33.4	-
10. Do you practice summerfallowing?	94.4	5.6	-
11. Is it an erosion promoting practice in your opinion?	44.4	38.8	16.6
12. Do you practice stubble burning?	22.2	77.8	-
13. Is it an erosion promoting practice in your opinion?	88.8	11.2	-
14. Do you perceive decline in crop yields due to soil erosion?	61.2	22.2	16.6
15. Are you satisfied with your current crop production pattern?	83.4	16.6	-
16. Do you think farm level erosion control is needed to maintain long term soil productivity?	66.6	11.2	22.2

construction. Ninety-five percent of the sample farmers are practicing summerfallowing and are distinctly divided in their views on the benefits associated with it. It is encouraging to find that only 22 percent of the farmers practice stubble burning. About 89 percent of farmers consider stubble burning an erosion promoting practice. Although a higher propotion (83.4 percent) of the farmers are satisfied with their farming operations, the remainder think they can do a better job. It should be noted also that 61.2 percent of the farmers clearly perceive a decline in yield and 66.6 percent of the farmers indicate that soil erosion control is needed to maintain soil productivity. One can conclude that appropriate policies designed to control soil erosion at the farm level will be evaluated positively by most farmers, since they perceive the existence of soil erosion problems. These results are consistent with earlier findings (Hoover and Wiitala 1980; Fisher, Boyle, Schulman and Bucuvolas 1979; Pollard, Sharp and Madison 1979; Seitz, et al., 1978; and Seitz and Swanson 1980). These earlier studies examine farmers' perceptions from a nonpoint pollution control policies perspective. Many farmers use summerfallowing, as they say, to retain soil moisture, control weeds, clean fields for seed bed, spread farm manure if a particular field is not paying, build soil productivity, and reduce fertilizer purchases. Farmers who perceived summerfallowing as an erosion promoting practice seem to disagree on the above points. There are 16.6 percent who are confused and do not know exactly how to assess summerfallowing practices. This obscure situation needs further systematic research. Finally, note from Table VII.2 that about 66.6 percent of the respondents viewed soil use from a long term perspective--a fair indicator of land use planning with an ethical perspective.

Table VII.3 indicates farmers' assessment of their own soil conservation practices. Deep tillage and cross-cultivation seem to be an effective combination in farmers' opinions. It should be noted that no respondent has doubted the effectiveness of grass waterways. Stubble management, fall cultivation and crop rotation with grass or forage crops are considered effective practices by a large proportion of respondents. Continuous cropping remains a doubtful practice in the respondents' minds. Contouring, up and down cultivation and discing are not considered to be effective practices by the majority of farmers.

Table VII.4 contains farmers' estimates of economic benefits from various combinations of soil erosion control practices. Minimum tillage, cross cultivation, trash and stubble management and fall cultivation have been proposed to farmers and Table VII.4 indicates their responses. Some farmers are, in fact, using some of the above combinations of tillage and conservation practices. A majority of farmers noticed an increase in crop yield in the range of 2 to 3 bushels per hectare. A large proportion of farmers also noticed an increase of 3 to 5 dollars per hectare in

TABLE VII.3

FARMERS' ASSESSMENT OF EFFECTIVENESS OF THEIR OWN CONSERVATION PRACTICES IN REDUCING SOIL LOSS

Practices	Effective	Not Effective	Don't Know
	- percent -		
1. Deep tillage	66.6	33.4	-
2. Discing tillage	5.6	94.4	-
3. Minimum tillage	44.4	55.6	-
4. Contouring	38.8	61.2	-
5. Cross cultivation	72.2	27.8	-
6. Up and down cultivation	22.2	77.8	-
7. Stubble management	72.2	27.8	-
8. Grassed waterways	100.0	-	-
9. Fall cultivation	61.1	22.2	16.7
10. Continuous cropping	50.0	33.3	16.7
11. Crop rotation with grass	66.6	22.2	11.2

TABLE VII.4

FARMERS' ESTIMATES OF ECONOMIC GAINS OF CONSERVATION TILLAGE AND PRACTICE

Efficiency Indicators	Lower	Same	Higher
	- percent -		
1. Crop yields	-	27.8	72.2
2. Operating expenses	16.6	11.2	72.2
3. Soil productivity	-	33.4	66.6
4. Time and Labour	61.1	34.4	5.6
5. Risk of crop failure	-	33.4	66.6
6. Problem with respect to:			
(a) weeds, insects and diseases	16.6	27.8	66.6
(b) planting, fertilizer and pesticide use	5.6	72.2	22.2
(c) germination	-	27.8	72.2
(d) need for additional equipment	-	33.4	66.6

production costs. A majority of farmers cited soil, time and labour-saving qualities associated with conservation practices. Farmers' perceptions of risk of crop failure and problems encountered using conservation practices indicate that, on balance, it is not profitable. This result may be due to the very fact that minimum tillage is more sensitive to the weather's adverse effects and demands more attention to all related aspects of crop production, including pest and weed management (Pollard, Sharp and Madison 1979; Johnson 1977; and Ketcheson 1977). Also, nearly 67 percent of the farmers indicate a need for additional equipment with minimum tillage.

Table VII.5 presents farmers' attitudes toward current soil erosion control policies. Although nearly 84 percent of the farmers think they have an adequate flow of technical information about the seriousness of erosion problems, 56 percent indicated that the technical assistance is not effective. Similarly, most of the farmers are aware of various legislative acts related to soil erosion control, but in their opinion, these acts and regulations result in procedures that are time-consuming, complex, ineffective and require reformulating. These findings are consistent with those observed by Phillips, DePape and Brook (1975) at the regional level. About 57 percent of the farmers do not think that cost-sharing arrangements for water management and ditch construction are effective, although all the sample farmers think that grass waterways are highly effective in

TABLE VII.5

FARMERS' ATTITUDES ON CURRENT SOIL EROSION CONTROL POLICIES

Questions	Yes	No	Don't Know
	- percent -		
1. Do you have access to technical information on the seriousness of erosion problems?	83.4	16.6	-
2. Is technical assistance available for crop management and water management effective?	44.4	55.6	-
3. Are you aware of various legislative acts of soil erosion control?	77.8	5.6	16.6
4. Do you think government regulations are effective?	38.8	55.6	5.6
5. Do you think cost-sharing arrangements for water management and grass waterways are effective?	44.4	55.6	-

reducing erosion. It can be concluded from Table VII.5 that existing soil erosion control policies need modification in order to resolve most of the deficiencies in implementing erosion control.

Table VII.6 presents perceptions of the fairness of several alternative policies to the existing policies. Although fairness reflects a basic attitude, it does not imply that the farmers have analyzed the policy from a societal perspective. Rather, it deals with whether or not farmers perceive a given policy as fair or unfair (Seitz, et al., 1978, p. 135). Table VII.6 also indicates approximate percentages of farmers who would voluntarily, mutually or mandatorily, participate in various proposed policies. Farmers were asked to indicate how fair each proposed policy would be. In general, education programs, changes in crop rotations and cost-sharing arrangements for soil erosion control practices were viewed by farmers as essentially fair. Cost-sharing arrangements, tax relief and low interest rate loans were suggested to farmers as possible economic incentives for the adoption of soil erosion control practices such as minimum tillage, stubble and trash management, substitution of legumes and grass rotations for summerfallowing and fall cultivation. Cost-sharing arrangements for these practices were proposed by respondents in the ratio of 40/60, that is, farmers' shares would be 60 percent of total costs. About 95 percent of the farmers viewed cost-sharing as a fair policy. This response

TABLE VII.6

PERCEIVED FAIRNESS OF ALTERNATIVE SOIL EROSION CONTROL POLICIES BY FARMERS

Policies	Fair	Unfair	Don't Know
	- percent -		
1. Education program	94.4	-	5.6
2. Change in crop rotation	72.2	16.6	11.2
3. Required development and implementation of approved soil erosion control plan	55.6	38.8	11.2
4. Economic incentives for soil erosion control practices:			
(a) cost-sharing (40/60)	94.4	-	5.6
(b) tax relief	16.6	-	83.4
(c) low interest rate loans	11.2	-	88.8
5. Voluntary implementation of policies	88.8	-	11.2
6. Mutual implementation	94.4	-	5.6
7. Mandatory implementation	11.2	88.8	-

clearly indicates that farmers are sensitive to the probability of private gain. Approximately 84 percent and 89 percent of the farmers, respectively, said they did not know how fair tax relief and low interest rate loans would be. Approximately 39 percent of the farmers felt that they would be unfairly treated if regulations requiring the development and implementation of improved soil erosion control practices were to be implemented. However, as the data in Table VII.6 indicate, approximately 57 percent of responding farmers perceived this policy as fair.

Approximately 89 percent of the farmers viewed mandatory implementation as unfair, whereas voluntary and mutual implementation policies were perceived as fair by more than 88 and 94 percent of the responding farmers respectively. The negative attitude towards mandatory implementation of soil erosion programs may be partly due to the high premium farmers place on their autonomy in farm decision-making and to the high value they place on unrestricted property rights. It can be concluded that there is, however, considerable scope to alter current policies and introduce alternative policies to minimize soil erosion in the Peace River region. It is also clear from the information presented in Table VII.6 that for feasible results, voluntary or mutual implementation approaches only should be considered. Mutual implementation places lower costs on farmers when they alter their practices.

C. Interpretation of Extension Workers' Response

This section presents an interpretation of extension workers' views about some general issues related to soil erosion problems and policies. Among the important questions addressed to extension workers were: (1) what are their perceptions of existing soil erosion problems; (2) what, in their opinion, are the important factors contributing to these problems; (3) what are their views about the fairness of the proposed policies; and (4) what are their predictions of participation rates. Most extension workers are seriously concerned with the magnitude and extent of soil erosion problems. In their opinion, summerfallowing, soil type, long gentle slopes, stubble burning, conventional tillage systems and absence of grass or forage crops in crop rotations are the most damaging factors contributing to soil erosion problems. Most extension workers believe that a well planned education program, including farm demonstrations to show comparative profitability of various crop rotations, should be given top priority. Creating an awareness of the problem in terms of economic gains and losses is very important in the view of extension workers. They also suggest that summerfallowing can be reduced through proper financial incentives such as cost-sharing arrangements for input costs associated with certain weed and insect control practices. Most of the extension workers viewed proposed policies as very fair. Regarding farmers' participation in the proposed policies, extension workers showed positive responses.

However, they tended to suggest a mutual implementation of these policies, rather than a mandatory one.

In summarizing extension workers' responses, it may be concluded, as with farmers, that there is general harmony among their opinions regarding proposed policies and in their perceptions of the problem situation. However, they have some conflicting opinions with respect to benefits from summerfallowing, tillage and conservation practices. This conflicting situation can be resolved only through systematic research and effective diffusion of the results of such research.

VIII. Institutionalizing Soil Erosion Control Policies

An institutional approach is used in this study to examine soil resource use and landownership rights, farmers' behaviour and its effect on soil characteristics, conceptual mistakes related to the soil loss measurement, farm and extension workers' perceptions of erosion problems, their experiences with current programs and policies, and their reaction to proposed policies. The purpose of this analysis is to obtain essential information on a wide range of soil erosion control policies at the farm level which could be analyzed in terms of efficiency, equality, legality and administrative characteristics. The initial section of this chapter presents background information on existing administrative organization concerned with soil erosion problems and current soil erosion and control policies. Section B contains a critical analysis of current soil erosion policies. Section C contains a discussion of the formulation and selection of alternative policies and social aspects of resulting proposed policies. Section D proposes an organizational structure to monitor the proposed policies. Proposed policies are evaluated using various criteria (Section E).

A. Existing Agencies, Programs and Policies

Figure VIII.1 shows problem areas to which erosion control measures apply and agencies responsible for the control of farm level erosion using various pieces of legislation. As is evident from the figure, problem areas to which corrective or preventative erosion control measures are applied are essentially physical in nature. These problems are the main causes of sheet, rill and gully erosion in physical terms. Each cause or problem is represented by a separate box and numbered as 1, 2 and 3 respectively. Similarly, corrective or preventative measures are also represented by boxes and the numbers of the three boxes are corresponding to the numbers of the boxes of problems and causes. For example, agro-climatic problems (box 1) are dealt with using corrective and preventative measures (box 1) of erosion control. Corrective and preventative measures (box 3 of erosion control measures) correspond to defective engineering structures (box 3), and so on. Courses of action currently available to control farm level erosion involves two major actors, namely, landowners or operators who seek government assistance; and government agencies who approach farm operators to seek cooperation. These courses of action involve various government agencies who are responsible for controlling farm level erosion problems. The responsibilities of these agencies are to implement corrective and preventative measures, pay in part for erosion control measures and administer legislative directives. Since a detailed description of the role and

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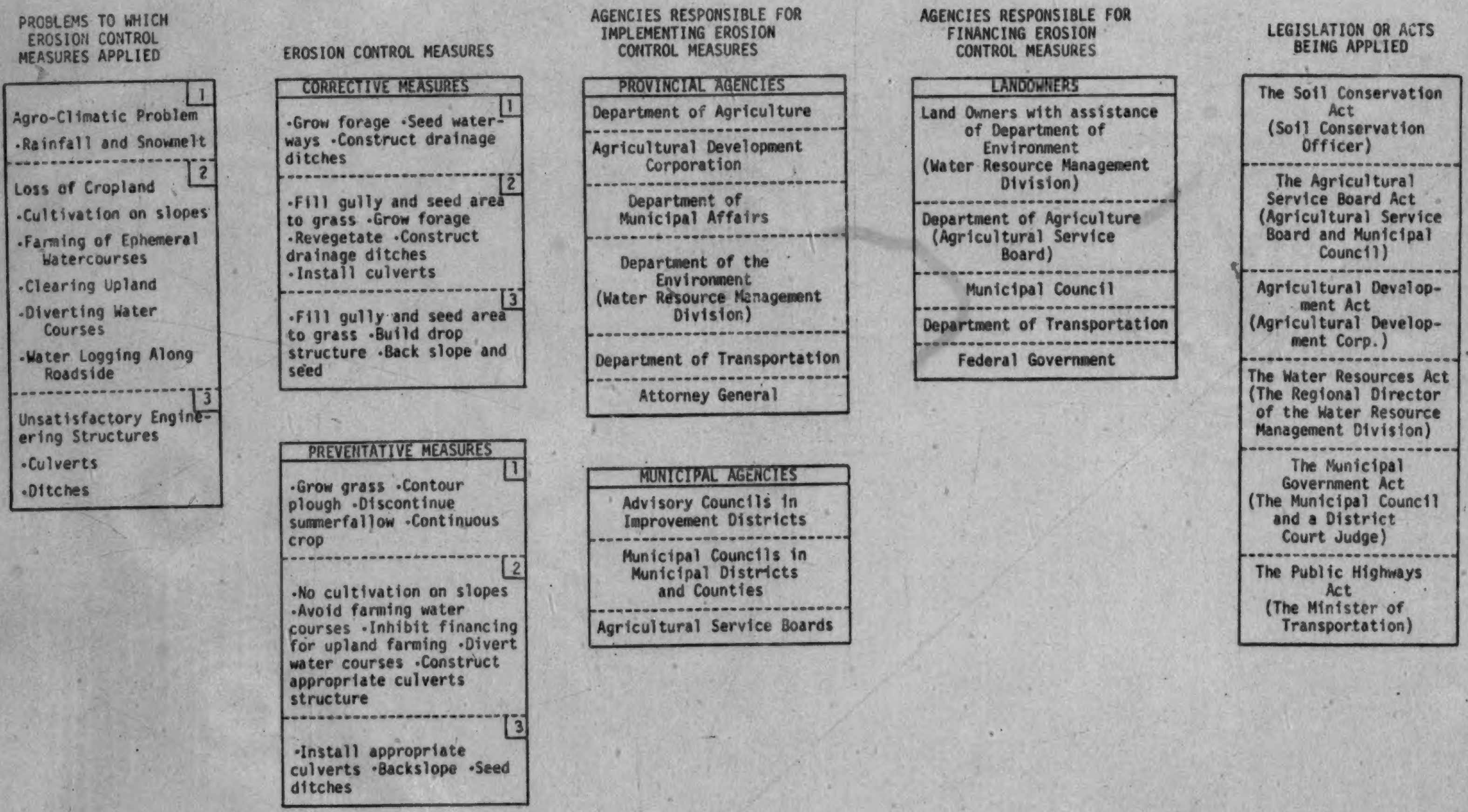
FIGURE VIII.1

EXISTING INSTITUTIONAL NETWORK TO CONTROL FARM LEVEL SOIL EROSION



PROBLEMS TO WHICH EROSION CONTROL MEASURES APPLIED

1. Agro-Climatic Problem
   - ·Rainfall and Snowmelt
2. Loss of Cropland
   - ·Cultivation on slopes
   - ·Farming of Ephemeral Watercourses
   - ·Clearing Upland
   - ·Diverting Water Courses
   - ·Water Logging Along Roadside
3. Unsatisfactory Engineering Structures
   - ·Culverts
   - ·Ditches

EROSION CONTROL MEASURES

CORRECTIVE MEASURES

1. ·Grow forage ·Seed waterways ·Construct drainage ditches
2. ·Fill gully and seed area to grass ·Grow forage ·Revegetate ·Construct drainage ditches ·Install culverts
3. ·Fill gully and seed area to grass ·Build drop structure ·Back slope and seed

PREVENTATIVE MEASURES

1. ·Grow grass ·Contour plough ·Discontinue summerfallow ·Continuous crop
2. ·No cultivation on slopes ·Avoid farming water courses ·Inhibit financing for upland farming ·Divert water courses ·Construct appropriate culverts structure
3. ·Install appropriate culverts ·Backslope ·Seed ditches

AGENCIES RESPONSIBLE FOR IMPLEMENTING EROSION CONTROL MEASURES

PROVINCIAL AGENCIES

- Department of Agriculture
- Agricultural Development Corporation
- Department of Municipal Affairs
- Department of the Environment (Water Resource Management Division)
- Department of Transportation
- Attorney General

MUNICIPAL AGENCIES

- Advisory Councils in Improvement Districts
- Municipal Councils in Municipal Districts and Counties
- Agricultural Service Boards

AGENCIES RESPONSIBLE FOR FINANCING EROSION CONTROL MEASURES

LANDOWNERS

- Land Owners with assistance of Department of Environment (Water Resource Management Division)
- Department of Agriculture (Agricultural Service Board)
- Municipal Council
- Department of Transportation
- Federal Government

LEGISLATION OR ACTS BEING APPLIED

- The Soil Conservation Act (Soil Conservation Officer)
- The Agricultural Service Board Act (Agricultural Service Board and Municipal Council)
- Agricultural Development Act (Agricultural Development Corp.)
- The Water Resources Act (The Regional Director of the Water Resource Management Division)
- The Municipal Government Act (The Municipal Council and a District Court Judge)
- The Public Highways Act (The Minister of Transportation)

responsibilities of these agencies is provided elsewhere,[39] only a brief summary of their policies and programs is provided here.

Historically, education has been a major policy instrument used by the Alberta Department of Agriculture to promote soil conservation rather than enforcement of soil conservation regulations. However, education was not considered adequate for controlling soil losses in certain situations. As a result, the Alberta legislature passed the Soil Conservation Act in 1962. The Act requires that every farm operator who owns, occupies or controls land shall take active measures to prevent land deterioration by wind, water or other causes.[40] Soil conservation officers are responsible for the administration of this Act. This Act also enables municipal councils to pass bylaws controlling or preventing the removal of topsoil and stubble burning. The enforcement of the Act has, in general, been left to local authorities. The Agricultural Service Board Act provides for payment of grants to municipal governments up to a maximum of $2,000, representing a 60 percent share of the cost of a special soil conservation program. Where the share exceeds $2,000, the municipality may apply for a Soil Conservation Area Program (SCAP) grant and receive up to $20,000, representing up to 80 percent of the project's cost. To control erosion and snow drifting, a field Shelterbelt Planting Program (SPP), including the provision of nursery stock, has been conducted by the Department since 1950. The Agricultural Development Corporation administers the Agricultural Development Act to control the clearing of uplands which may be a contributing factor to soil loss.

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[39] More details of the policies and programs of agencies that apply to the subject of soil erosion are provided in *Erosion of Land in Northwestern Alberta: A Summary of Provincial Government Policies and Programs*. Environment Conservation Authority, Information Bulletin No. 5, December 1975. See also Phillips, DePape and Brook (1975) for an outline of the mechanism involved regarding the programs and policies of the various agencies.

[40] See Appendix II for a full description of The Soil Conservation Act.

The Department of Municipal Affairs, through its municipal agencies, has responsibilities to control various kinds of soil erosion by encouraging proper agricultural practices. Under the provisions of the Agricultural Service Board Act, Agricultural Service Boards (established in the improvement districts) recommend various cultural practices and programs to minimize soil erosion, and it is possible under this Act to spend municipal funds on remedial action to correct already existing erosion problems. Municipal Council with the Department of the Environment, Water Resources Division enter into agreements on a 50/50 cost-sharing arrangement with respect to drainage and water management projects.

The responsibilities of the Department of the Environment with respect to farm level erosion control are directly related to the Water Resources Act. The Act forbids the diversion of water or, with conservation or water management, if an illegal diversion of water has taken place which results in increased erosion damage, an inspection is conducted and appropriate enforcement action initiated by the staff of the Department of the Environment. The Department of the Environment shares the costs of erosion control projects with the Department of Municipal Affairs and also assists the Department of Agriculture in erosion control projects by providing engineering and technical assistance to Agricultural Service Boards.

The Department of Transportation is responsible for preserving natural drainage when designing and constructing major engineering structures (culverts, ditch checks, etc.) along roadsides and for avoiding loss of topsoil during construction. Under the provision of the Public Highways Development Act, the Department of Transportation will share with the municipality the costs of construction and, in some instances, maintenance of secondary roads. Under this Act, provision is made to receive a landowner complaint to property drainage from provincial highway drainage. A landowner has similar rights related to municipal highways under the Municipal Government Act. The Attorney General may be involved where action is brought to court under The Soil Conservation Act, The Water Resource Act and the Municipal Government Act. The Federal government may share in erosion control projects if the provincial government applies for it through The Agricultural Rehabilitation Act and the Prairie Farm Rehabilitation Act.

Currently, most courses of action taken that involve erosion control are initiated by farm operators rather than government. However, farmers' actions are generally limited to seeking information about construction of grass waterways or other cost-sharing programs. There is also legislation available enabling government agencies to approach a farm operator responsible for a specific erosion problem. This channel is taken only upon complaint from one or more other farm operators who are affected by the problem. Complaints may also arise from an erosion problem associated with drainage or provincial and/or municipal highways. In other words, legislative channels are used where external effects are involved.[41]

Figure VIII.2 shows a mechanism which is currently in operation for controlling external effects of farm level soil erosion. The channels of action taken depend upon the nature of the erosion problems involved and vary widely in detail and complexity. For example, there are six alternative courses of action open to farm operators who are concerned with external effects of farm level erosion or drainage problems (Phillips, DePape and Brook 1975, p. 17). Each channel has its roots in conflicts of interest with respect to resource use. For example, in a situation where a farmer has a complaint about erosion occurring as a result

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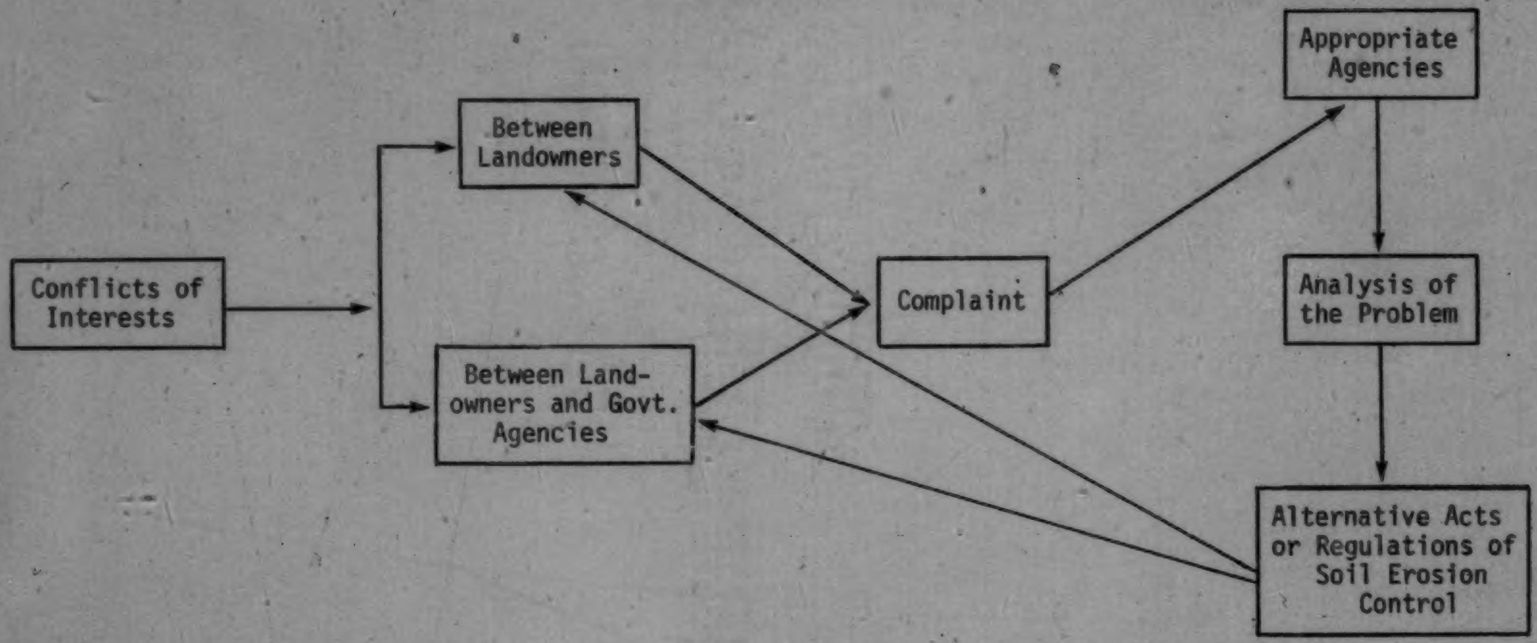
[41] See Phillips, DePape and Brook (1975) for a detailed and comprehensive description of various channels open to individual farmers and government agencies and to the extent to which these channels are used for minimizing farm level soil erosion problems.

FIGURE VIII.2

EXISTING CHANNELS OF ACTION FOR CONTROLLING EXTERNAL EFFECTS OF FARM LEVEL SOIL EROSION


Conflicts of Interests
Between Landowners
Between Land-owners and Govt. Agencies
Complaint
Appropriate Agencies
Analysis of the Problem
Alternative Acts or Regulations of Soil Erosion Control

of a neighbour's action (conflicts between two landowners, Figure VIII.2), the affected farmer may bring the problem to the attention of the appropriate department(s). In this situation, an Agricultural Service Board officer is an appropriate agent if the affected farmer has a legitimate complaint.

However, in the case of a neighbour's water diversion project, the affected farmer may also write to the Regional Director of the Alberta Water Resources Management Division. Upon hearing the complaint, the Agricultural Service officer analyzes the problem and may either simply approach an offender directly and outline measures that will resolve the issue, or serve a written notice to the offender requesting that corrective measures be taken (the latter has not yet been followed in the Peace River region). If the offender complies with the notice, the issue is resolved; if the offender objects, a municipal appeals procedure may be followed. If this procedure results in a decision in favour of the complainant, then the offender either complies, thus resolving the issue, or does not comply, thus facing a fine, imprisonment or seizure of his land until the issue is resolved. The Agricultural Service officer may also choose to prepare a report of his findings and submit this to the Agricultural Service Board for further investigation and financial assistance to fund a project to alleviate the erosion problem. The Agricultural Service Board Act and the Soil Conservation Act provide "power" to the Agricultural

Service officer (or Soil Conservation officer) to act as "government in action" and choose appropriate alternatives to control soil erosion.

Conflicts of interest may also arise in cases where an offender is engaged in a water diversion project. A complainant may approach the Regional Director of the Water Resource Management Division (conflict between landowners). If the offender holds a license, the water diversion project may become subject to a legal government inspection. If the neighbour does not hold a license for water diversion, then he may be guilty of an offence and therefore may be either requested to apply for a license, have his diversion work destroyed, or become subject to a conviction under the provision of the Water Resources Act.

A situation in which a farm operator's interest may conflict with the government agency's may arise when he has a complaint about an erosion problem associated with drainage of provincial or municipal highways. A highway ditch, for example, may divert the flow of water into a cultivated field, resulting in sheet, rill or gully erosion. In such cases, a landowner may notify the Minister of Transport or the Municipal Council (whichever the case may be) of the complaint. Under the provision of the Public Highways Development Act and the Municipal Government Act, the Transport Department (if the problem is due to provincial highways) or Municipal Council (if the problem is due to municipal roads) takes corrective action to resolve external effects.

In some situations, a farmer's own actions on his farm may result in external effects. For example, if a particular cultivated area is susceptible to flooding from spring runoff, damage to this and other fields may result. If a farmer wishes to deal with a problem of this nature, he may take one of several courses of action. These channels deal mostly with corrective engineering measures (culverts and ditches). For other corrective measures, he may seek information from appropriate agencies to correct the erosion problem (Phillips, DePape and Brook 1975, Charts 1-9).

The foregoing analysis has presented a general overview of the programs and policies presently administered by major agencies, with major responsibilities relating to farm level soil erosion control in the Province of Alberta. The focus of most of the existing programs and policies is on corrective action. Furthermore, this focus is on spatial external effects which only considers the secondary problem, but ignores the root causes. In recognition of the multiplicity of government agencies and pieces of legislation related to soil erosion prevention and correction, coordination efforts have been formalized through the recent formation of PACE (Provincial Action Committee on Erosion) and RACE (Regional Action Committee on Erosion). These committees are made up of regional and provincial representatives from the various government agencies. The express purpose of these committees is to deal with soil erosion in a more effective manner than previously. In order to determine the effectiveness of existing programs and policies, a critical evaluation of current policies is necessary. This chapter is now directed towards this goal.

B. Evaluation of Existing Programs and Policies

As indicated in the previous section of this chapter, existing programs and policies for erosion control measures, which are mainly corrective in nature, generally refer to location externalities arising from water diversion, and involve the use of culverts, drainage ditches and grass waterways. Existing policies and programs available to farm operators and government agencies generally ignore farm level soil erosion problems which are closely related to farming practices and farmers' perceptions of soil resource use in the Peace River region. In this section, the existing institutional network is examined in terms of overall capability and effectiveness of existing policies in bringing about some degree of correspondence between the action of farm operators and government agencies on the one hand, and the interest of society on the other. Whether or not farm level soil erosion problems can be dealt with through the modification of the existing institutional framework is also examined.

The focus of most of the current corrective and preventative soil erosion control measures is on those problems which are secondary in nature (see Figure VIII.1). These problems arise essentially from the actions of farm operators or government agencies (erosion due to road construction or unsatisfactory engineering structures). At present, most courses of action are taken in cases involving erosion control and only after problems of external effects of erosion have manifested themselves through farmer diversion of water onto neighbouring lands, or through the development of roads and resultant altered drainage systems which affect nearby farmlands. As indicated earlier, channels of recourse exist to resolve these problems. When a farmer has a complaint about erosion occurring as a result of a neighbour's action, or local or provincial government action causing erosion problems, channels exist to control the problem and to compensate those affected via a typical externality solution framework. Present legislation or acts (mainly corrective in nature) apply only to these secondary problems.

There is some provision under The Soil Conservation Act to make farm operators responsible for erosion control on their farms. If a farmer fails to remedy an erosion problem, the local Agricultural Service Board can take corrective action and bill the farmer for costs incurred. However, this provision in the Act has been used very infrequently and never used in connection with water induced erosion at the farm level. Local Agricultural Service Boards may be reluctant to undertake such action, even as a last resort, because of potential ill will that may result. Furthermore, there is no provision in the Act for the development and implementation of farm plans designed to minimize soil loss at the farm level. Legislation is also lacking for the development and implementation of preventative measures.

Most existing corrective and preventative measures and associated channels of actions are rarely, if ever, used because of their complexity, time requirements, expense and lack of enforceable regulations and guidelines (Phillips, DePape and Brook 1975). For example, legislation which calls for grass cover as a remedy for sheet erosion and legislation pertaining to gully erosion problems caused by cultivation on slopes and watercourses are not being applied widely, even though assistance may be obtained from the Water Resources Management Division, the Agricultural Service Board, or the Municipality. A farm operator or a group of farm operators wishing to undertake a water diversion project for the purpose of erosion control, require a license from the provincial government. The many steps involved in obtaining the license can take as long as two years with no guarantee of success. Further steps may also be involved, for example, in the event that technical assistance is required, thus adding to the complexity. To avoid complex and time-consuming procedures, the practice most commonly used by private landowners is to circumvent formal channels (Phillips, DePape and Brook 1975). The complexities of formal procedures, coupled with the emphasis on corrective action, render current policies somewhat ineffective in dealing with soil erosion problems and particularly those at the farm level.

The administration of current erosion control legislation and measures is shared by many local and provincial agencies (Figure VIII.1). These agencies have major responsibilities for land management, including the control of erosion induced or hastened by man's activities. However, a lack of coordination between government agencies and poor communication with farm operators tend to result in aggravated confusion and a high frequency of inaction regarding soil erosion control. There have been cases in the Peace River region of communication breakdown among various government agencies. For example, available funds have not been used by a municipality for erosion control because of extended delays in the Alberta Water Resources Management Division Surveys and the necessity of following complex and ineffective licensing procedures (Phillips, DePape and Brook 1975). Another example relates to cost-sharing arrangements between municipalities and the Alberta Water Resources Management Division, which are based on municipal financial capabilities rather than program funding requirements. Even though municipalities in the region vary in size and erosion needs, they must operate on fixed budgets. Hence, funds made available for erosion control may be based on criteria other than erosion control requirements (Phillips, DePape and Brook 1975). Further, improvement districts, when dealing with special soil erosion cases, must go through provincial authorities to fulfill decision-making functions. Thus, creating further delays and inceased complexity in problem solving. Similarly, Alberta Agriculture, Alberta Transportation and Alberta Environment differ on designs and uses of drainage and other erosion related structures. These examples suggest a need for greater interdepartmental coordination to deal with an ongoing concern.[42]

The capabilities of existing policies to bring about some degree of correspondence between the action of farm operators, government agencies and the interests of society are now examined. As mentioned above, most existing channels of erosion control do not deal with the root causes of the soil erosion problem. The root causes of soil erosion in the Peace River region are directly related to farming practices and short-run perceptions of farm operators towards soil resource uses. Channels within the purview of provincial legislation pertain largely to correction of external effects in location and completely ignore the conflicts of interest between landowner and non-owner and between present and future generations (Figure VIII.2) on soil resource uses. Policy omissions with respect to the temporal dimensions may not only encourage farmers to mine soil resources, but may also have serious implications regarding qualitative and quantitative characteristics of soil resources. The actions of present landowners in dealing with soil erosion can have significant consequences for the quantity and quality of soil resources available to future farmers. In light of this implication, a Peace River farmer, acting in his own best interest, even in absence of spatial external effects, may not act in the best interest of society if he fails to consider future users of the land.[43]

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[42] The implementaton and coordination problems illustrated here are certainly recognized by public entities. Their concern for these problems has led to the recent formation of PACE and RACE. These committees represent an initial step to consolidate and coordinate efforts directed toward effective action in dealing with water induced soil erosion. However, a great deal more development in the restructuring and formulating of institutional arrangements that deal with these problems is required and outlined herein.

Since water induced soil erosion is directly related to farming operations in the Peace River region, the core issue becomes one of changing current soil erosion farming practices. To alter current farming practices, it is most vital to change the static perception of farmers towards soil resource use. The existing institutional network does not provide wide-ranging opportunities to induce altered farm operator behaviour. Courses of action available currently are often unable to facilitate correction of external soil erosion effects for which they were formulated. Substantial modifications are required if current channels of action are to be used to correct secondary effects of farm level erosion problems. However, if prevention and planning are properly undertaken at the farm level, many corrective measures related to external effects become unnecessary.

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[43] These issues have been dealt with in detail in Chapter IV.

Farm level policies and plans should reflect a concern for future generations as well as a response to present problems which arise from past practices. The problem then is one of searching for a set of working rules or institutional arrangements that impose minimal costs on those farm operators whose current behaviour or action requires modification. The modified or altered behaviour should lead to improved soil management performance (less soil loss at the farm level).[44]

To bring consistency between farmers' behaviour and society's expectations with respect to soil resource use, the following measures are proposed: education (farmland demonstrations, adequate flows of technical information and assistance), crop rotation changes with increased forage crops, an approved soil conservation plan development and implementation, cost-sharing arrangements for soil erosion control practices, and land use restrictions that limit landowners' rights. A greater coordinaton among government administrative agencies, a well coordinated research effort including university, provincial and national institutions, a well defined financial structure involving federal, provincial, and local governments and farm representatives, are all essential ingredients in the proposed institutional arrangements. This network is extended in the next section.

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[44] A wide range of institutional arrangements is proposed in Chapter IV (Figure IV.1) and Chapter V (Figure V.3).

C. Formulation and Selection of Policies

The approach followed for formulation of a wide range of institutional arrangements is outlined in Chapter V. To ensure that a wide range of potential farm level soil erosion control policies are considered, a structure of institutional arrangements has been developed and shown in Figure V.3. These institutional arrangements have been developed keeping in view the root causes of soil loss, and resultant private and social costs (see also Figure IV.1). Structures of institutional arrangements are the various working rules or policies which can be used to induce farm operations (conduct), so as to achieve desired objectives (performance), such as reduction of soil erosion, maintenance of qualitative and quantitative soil characteristics, and internalization of spatial and temporal effects.

Using the available information on existing policies and legislation, farmers' and extension workers' perceptions, conceptual mistakes related to soil loss measurement, and approaches outlined in Figure V.3, five general policies are proposed. These policies are then subject to evaluation using various criteria. In the following discussion of these policies, their general nature is specified without indicating the specific elements to be used. The general description is considered adequate for the analysis which follows. Decision makers in the policy arena may set the specifics for each proposed policy.[45]

Education: An education policy would promote erosion control through persuasion and awareness within the farmer's community of existing and potential farm level problems. Although many farmers are aware of actual and potential soil erosion problems stemming from their current soil erosive farming practices, they do not have compelling reasons to eliminate these practices.[46] Furthermore, extension workers lack backup informaton regarding soil erosion, particularly information concerning the advantages of soil erosion control practices over erosive practices. Through field-level or experimental station demonstrations, public meetings, farmer representation, seminars, films, publications, radio and television programs and various other potential programs, an education policy could provide information on the benefits of soil erosion control practices and the associated effects of maintaining soil productivity to both farmers and other citizens. Because of its voluntary nature and a positive approach to the reduction of soil loss at the farm level, an education policy acceptance rate has been historically very high (see

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[45] Policies related to financial incentives were also used by Seitz, et al. (1978) and Moore, Sharp, Berkowitz and Schneider (1979) to control nonpoint source pollution.

[46] For example, reduction of summerfallow could not be effectively pursued by the extension media due to the lack of demonstration projects, and inadequate flows of technical information backed by scientific findings. See Chapter VII for awareness and attitude of farm operators concerning erosive practices.

Table VII.6). Improved awareness of the problem could make this policy relatively simple to implement. However, it requires extensive involvement of extension workers.

Research: Soil erosion research efforts in Canada in general[47] and in the Peace River region in particular, are not, at present, extensive. There is an urgent need for a well coordinated research wing to conduct research involving social, economic, legal, political, ethical and agronomical aspects of soil erosion. This policy could help clarify and quantify some basic misconceptions (for example, quantification of soil loss and short-run advantages of soil erosive practices) and provide a wide range of economic and institutional arrangements to policy makers, extension workers and farmers. To provide a continuous and adequate flow of scientific information on soil resource use to farmers, extension workers and society could be the basic function of this policy. Organizational and financial aspects of this policy are discussed in the latter part of this section.

Cost-Sharing: At present cost-sharing programs are only available for water diversion and grass waterway construction in the Peace River region. Farmers assume approximately 20 to 30 percent of the costs on farms of labour provision and in kind for these corrective measures for external effects. However, financial incentives are not available for practices directed at the prevention of soil loss at the farm level and maintenance of soil productivity in the Peace River region. Under a 60/40 cost-sharing policy, whereby 40 percent of the costs of implementing approved soil erosion control practices on particular farms would be borne by government and the remaining 60 percent would be borne by farmers, adoption of desirable practices may be enhanced. This policy is proposed because of its perceived success capability by farmers and extension workers to induce desired performance and because of its expected implementation feasibility by these same entities. The Agricultural Service officer or soil conservation officer would be involved in administration, financing, and implementation of this policy. Cost-sharing would provide financial incentives to farmers to use soil erosion preventative practices. This policy can be successfully implemented if information about current cost-sharing practices is readily available and the practices funded are likely to be compatible with farm level technology in the Peace River region.

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[47] See Agricultural Institute of Canada Task Force Report in *Agrologist* 9 (Fall) 1980: p. 28.

Development and Implementation of An Approved Soil Erosion Control Plan: A policy requiring the development and implementation of a soil erosion control plan can be either mutual or mandatory in nature. The required plan could be developed, with the cooperation of farmers, by extension personnel. Development of farm plans could make farmers aware of desirable practices to reduce soil loss on their farms through the provision of on-farm planning technical assistance. Furthermore, this provision could be supplemented with financial assistance for the implementation of the plan. This policy is proposed here because it offers the most promise for farm-level soil erosion control. It allows choices from a wide range of alternative soil conservation and tillage systems. This policy can also provide a framework for considering altered soil resource uses in an ethical perspective.[48] While developing farm plans, both farmers and extension workers could keep in mind what farmers "ought to do" or "ought not to do". This policy also imposes certain restrictions on land use and, consequently, on private landownership rights.

Revision of the Soil Conservation Act: The The policy orientation proposed here requires a review and appropriate revision of the soil conservation act in order to provide more effective preventative erosion control at the farm level. The revised act may include the provision of development and implementation of soil erosion control plans, financial incentives, vigorous and concerted efforts at moral education of those in the business of agricultural land management, and a well defined research scheme. All the administrative, financial and monitoring functions of the various agencies to perform the above proposed policies should be well defined in the revised Act. Thus, the revised Act should place emphasis on the root causes of erosion processes, rather than secondary problems. This policy has the assumed capability of inducing desired changes in farming practices and is considered feasible for implementation. The enforcement of this revised Act could be realized on a magnitude comparable to that under The Weed Act and The Agricultural Pests Act.

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[48] See Kaufman (1980) and Barnes (1980) for land use aspects in an ethical perspective.

It is important to realize that all of the soil erosion control policies proposed here are designed to bring about some degree of correspondence between the actions of farm operators and the best interests of society. As mentioned in earlier chapters, the loss of the productive scarce soil in the Peace River region is the result of the static, self-interest behaviour of farm operators who enjoy the liberty of private landownership. Self-interest behaviour coupled with private landownership create conflict and disorder among farm operators, between farm operators and non-operators and between present and future generations.

The proposed policies place some limitations on the actions of farm operators and are capable of providing better farmer-to-farmer relationships with respect to landownership. In other words, the adopted working rules (proposed policies) define person-to-person relations regarding property limits and control. Farm operators pursuits based on their short-run perception of soil resource use can be altered by influencing their thought patterns, behaviour and expectations. Collective actions in terms of formulation of policies from social points of view, restricts, liberates and expands individual behaviour or action. Those relationships can be analyzed in terms of any or all of the eight fundamental relations in the Commons' Schema of Relations (Figure V.1a and V.1b). For example, the right of party A or farmer A to act imposes a duty on party B or farmer B to act in accordance with the right being asserted. But rights are subject to limits. The limit of farmer A (or party A) is his exposure, which provides a liberty for farmer B (party B). Thus, rights and liberty are capabilities while duty and exposure are constraints in an authorized relationship (see Figure V.1a). In terms of relations between a soil conservation officer and farm operators A and B (or parties A and B), the soil conservation officer (G) has powers under the provision of the Soil Conservation Act to place liabilities on the farm operators (A and B) with respect to soil resource uses. The limit of liability is immunity, and the immunity of a farmer provides a disability to the soil conservation officer (G) by limiting his power. Here power and immunity are capabilities, and disability and liability are constraints in authoritative relationships (Figure V.1b). Interpretation of authorized and authoritative relationships can be jointly discussed with the help of Figure V.2. The capabilities of the proposed policies and their effectiveness in institutionalizing economic behaviour of the farmers are discussed in the latter part of this chapter using Commons' principles of futurity, scarcity, efficiency, custom and sovereignty and other criteria.

However, without a well defined organizational setup which can integrate the administrative, financial and research activities, the full potentialities of the proposed policies can not be obtained. The existing agencies responsible for controlling soil erosion lack coordination with one another and are incomplete as organizations designed to perform complex tasks such as soil erosion control. To this end, a comprehensive organization set up for soil erosion control at farm level is proposed.

D. Organizational Structure

As discussed earlier in this chapter, a lack of coordination among government agencies and poor communication at the farm level are evident in the Peace River region. Besides lacking interdepartmental coordination, weak coordination within a department on matters such as those relating to land use and water management within a department's jurisdiction, is also evident. In the existing organization setup, there is little or no provision for farmer or citizen participation as a partly governed body (i.e., a farmer committee system or community organization). Making use of farmer expertise could be most helpful in minimizing and preventing erosion damages. Community organization or representation is also important since the financial incentives for soil erosion control may be judged from a public perspective. The community as taxpayers may pay part of the cost of implementing conservation practices and would expect the farmer to sustain these measures. Both links are missing in the current organization structure.

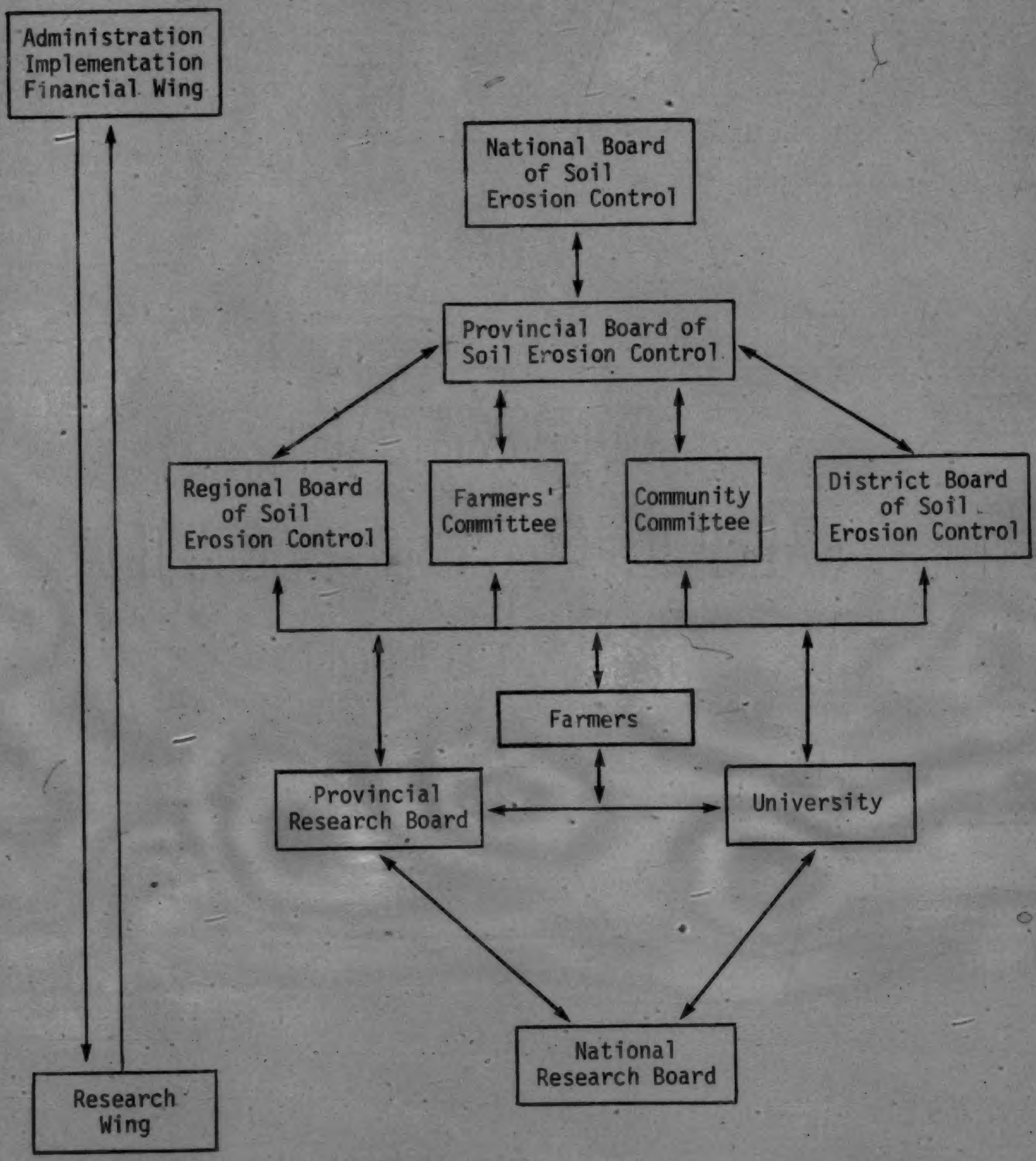
In existing policies, farmers have virtually no economic incentive to use soil conservation practices and tillage systems. Farmers often cannot adopt soil erosion control measures, even when knowledgeable about the comparative advantages of these measures, because of limited funds. Provincial and municipal agencies only provide support for the installation of culverts and grass waterways. Furthermore, these agencies (particularly municipal ones) operate on fixed budgets. In order to finance the proposed financial incentives policies, funding sources need to be determined. Maintaining a productive agricultural base for future and present generations is a society benefit which can be withheld from no one. The simple question is then: who should pay for something everyone wants (Libby 1980, p. 155)?

Erosion problems that may seem very important in the Peace River region may be considered quite unimportant from a provincial or national perspective. However, provincial and national priorities must be set without regard as to how they might affect a particular area. Benefits from agricultural production are national as well as provincial and regional; so is the responsibility. Thus, the proposal is made herein that national, provincial and regional boards administer finances for soil erosion control measures and soil erosion research activities be established along with a well coordinated research wing involving university, national research and provincial research agencies. A proposed organizational structure is presented in Figure VIII.3 which can effectively administer, finance and monitor the proposed policies.

The proposed organizational structure integrates the administration, implementation, finance and research activities at the national, provincial and local levels. Under the proposed system, most of the policies would be administered and financed at the regional level. Farmers can approach the district soil erosion control board for financial and technical assistance and for assistance with problems. There would be immediate need to extend staff personnel to district level since most of the proposed policies would be administered by regionally based provincial personnel. Agencies presently responsible for soil erosion control would work as a unit at provincial, regional and district levels for soil erosion control purposes. In the proposed structure, the most financial

FIGURE VIII.3

ORGANIZATIONAL STRUCTURE FOR SOIL EROSION CONTROL


Administration Implementation Financial Wing
National Board of Soil Erosion Control
Provincial Board of Soil Erosion Control
Regional Board of Soil Erosion Control
Farmers' Committee
Community Committee
District Board of Soil Erosion Control
Farmers
Provincial Research Board
University
National Research Board
Research Wing

support would be generated by federal and provincial governments to support the proposed policies. All agencies (research as well as administrative) in the proposed structure would operate in a close interaction loop. The proposed structure is superior to the existing organization in the sense that characterizes the organized institutions. The origin of organized institutions lies in necessity, scarcity and coordination. The existing agencies may be characterized as unorganized institutions as they operate somewhat independently and are not able to regulate human behaviour due to weak authority and authoritative relationships.

E. Performance of Proposed Policies

A comprehensive analysis of the potential performance of the proposed policies is presented in this section. Analyzing the performance of potential soil erosion control policies is one of the most vital steps in the iterations in the ongoing policy making process. The analysis of short-run and long-run impacts of policy alternatives needs to be addressed. Economists have been using efficiency and equity (distributive justice) as two major criteria in policy analysis since the seventeenth century (Mill 1929).[49]

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[49] On distributive justice, see the work of Hicks (1939), Kaldor (1939), Scitovsky (1941), Samuelson (1950) and Graaf (1963). Their work is related to the great controversy over whether the ability to pay or benefit principle (both are principles of equity) should regulate the extent and distribution of taxes and benefits by government. Controversy still exists (Feldman 1971). For a novel

[49] One of the most traceable facts of all time is attempted by economists to influence government by demonstrating efficiency gains or losses arising from government policies and programs. Yet the forceful argument in government deals not with efficiency, but with distributive justice. As a result, economists do not command policy-makers' acceptance of their advice (Feldman 1971, pp. 508-510).

One of the reasons for the lack of serious regard for economists' input in the political arena may be the fact that only a narrow range of criteria is used in the analysis of expected performance of alternative policies. Further, some of the conventional performance criteria are not satisfactory, if used as such, because they are abstract. For example, the benefit from public expenditures on an education program related to soil erosion control should not be measured simply by comparing farm operator incomes with the society costs, but by comparing as well the returns to society with the costs to society (in terms of reduction in soil loss, low food prices, improved environmental quality and future security in resource use, etc.). Thus, if economic reasoning is to have any impact on policy-makers, a systematic means of dealing with efficiency and equity criteria must be developed. This development will permit economists greater credibility with policy-makers, and tend to make policy-makers more amenable to take economic advice.

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[49](cont'd) interpretation of equity, see Commons (1924, 1934a), Rawls (1971) and Heilbroner (1974).

At this point, a range of criteria is proposed for an assessment of the performance of the prospective policies.

E.1. Alternative Criteria of Performance

Although the conventional[50] criteria (efficiency and equity) are used, a value judgement, together with Commons' ethical values concept, are also used to broaden the scope of these criteria. Commons' ethical values[51] deal with the social conditions of scarcity, equity, liberty and material abundance that man needs to pursue self-realization (Commons 1924, pp. 29-60). Regularities in economic behaviour or transactions of individuals are a function of Commons' above-mentioned interdependent principles. Incorporating Commons' interdependent variables into conventional criteria should result in the provision of a better criterion formulation to evaluate the conduct of farm operators, and consequently, the performance of the proposed policies. With this formulation, the scope of the criteria will be broader since those variables whose values should be estimated in analysis, will be identified. This identification of variables is of practical value to policy-makers who must determine the allocation of public expenditure. The following are the proposed criteria.

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[50] Schmid (1978, pp. 239-250) argues against the conventional criteria, but leaves the reader with his own value judgement or that of the client being served.

[51] These concepts have been dealt with in Chapter V.

E.1.1 *Efficiency Criteria*

In neoclassical theory, efficiency is simply an abstract concept on the ratio of values of selected inputs to selected output. Efficiency calculations are most meaningfully applied if property rights determine the selection of specific combinations of inputs and outputs (Ciriacy-Wantrup 1952, pp. 27-47, 1967, pp. 181-184; Haveman 1973, pp. 876-877; Howe 1979, pp. 149-164; Schmid 1978, p. 241; and Veeman 1978, pp. 80-85). In other words, an individual's relative opportunity set based on choices of property rights determines the content of input and output categories. Thus, rights determine efficiency and a given institutional arrangement achieves a given performance objective.[52] Efficiency and rationality are closely related and, while assessing performance of any policy, it is imperative to discover inconsistent choices or contradictory policies. When there are conflicts of interest or interdependencies involved in human interactions, it is not sufficient to know the efficiency of the proposed policies. One must also know about its (policy) effectiveness and for whose interest it is intended (Schmid 1978, p. 242).

To assess the efficiency of the proposed policies, two criteria, namely economic impact and institutional cost (administrative cost), seem to be particularly influencial in well specified property rights arrangements. The first criterion (economic impact) deals with the possible gain in farm income (property owners), surplus (non-property owner or taxpayer) and soil loss reduction capability of proposed policies. The second criterion deals with the administrative cost to finance and monitor the particular policy. Thus, unlike the conventional notion of efficiency with zero transaction cost, the proposed criterion of administrative cost relates to the institutional cost or transaction cost in property rights arrangements.

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[52] Using this concept with ethical values, Commons studied conditions in the American labour market to evaluate existing economic welfare (Commons 1913).

E.1.2 *Equity Criteria*

Consideration of equitability aspects is often omitted from, or is a minor part of, the overall analysis of expected performance of alternative policies. As a result, economists' input is often not seriously regarded in the public policy arena. Thus, proposed policies are assessed in this analysis, not only for their effectiveness in correcting or preventing soil loss or creating economic gains to property owners, but in respect of other factors including equitable distribution of gains and losses among different segments of society (non-property owners) resulting from these proposed policies. Of equal importance is the degree of correspondence between individuals' outlays for benefits received (non-property owners and future generations) and farmer compensations for costs incurred to replace certain soil erosion practices (property owners) with improved land resource use practices.

Seitz, et al. (1978) developed three criteria for judging the equity effects of alternative policies for controlling nonpoint agricultural sources of water pollution. These three equity criteria, namely, equality, earned rewards, and least risk, are used here to assess proposed policies because they anticipate the ethical trend for the near future. In addition to these three criteria, freedom and security are proposed as additions to the equity criteria. The equality criterion assesses performance of proposed policies in terms of reducing income or wealth differences between property owners and non-owners.

The earned reward criterion of equity reflects the fact that an individual's reward should be proportionate to his contribution. It states that those who receive the benefit of a good or service should pay for its cost of production. It rests on the ethics of earned rewards. For example, forcing a farmer to pay full cost for the adoption of conservation practices may raise short-run prices of agricultural products. Since everyone gains from soil conservation measures in terms of low long-run food prices and an improved environment, everyone should contribute to the cost of applying these conservation measures.

The third criterion (least risk) assesses the performance of policies in terms of increased soil resources conservation for future generations and decreased dependence on technical processes that may have adverse future consequences. In the case of soil erosion prevention, conservation measures taken at present may assure a better productivity base of soil resources for future generations than otherwise. This criterion also reflects equitable gains and losses resulting from present soil use among present landowners and non-landowners, and future landowners and non-landowners.

The fourth criterion of equity is freedom and security. When interests conflict in the face of scarcity, the great moral choice in any society is whose freedom counts. Freedom and security in the abstract are not satisfactory performance variables (Long 1953, p. 319; Schmid 1978, p. 240). Freedom and security are closely allied with power and rights. In general, it means the mundane, practical ability to exercise one's powers or faculties in the social order and to survive and prosper in so doing. Rights are relative and subject to change as power relationships and societal needs change (Commons 1924, p. 29). The purpose of the freedom and security criterion is to assess the performance of proposed policies in terms of limits on actions of landowners to protect the freedom and security of present and future generations (both owners and non-owners).

E.1.3 *Capability Criteria*

For judging the capability effects of proposed policies, three criteria are used: acceptability, incentive and adoptability. The acceptability criterion deals with the acceptability of the proposed policies by farmer and extension workers. It also assesses legal, political and social acceptability of the proposed policies. The incentive criterion for improved performance assesses the proposed policies in terms of their success in inducing improved behaviour on the part of farm operators. The adoptability criterion analyzes the suitability of the proposed policies to current farm level technology and to current operating organizational setups. Each criterion relating to capability is self-explanatory and takes into account major segments of the policy process.

E.2. Potential Performance Analysis of Proposed Policies

To analyze the potential performance of proposed soil erosion control policies in terms of the criteria developed above, performance matrices (Tables 8.1, 8.2, 8.3) have been constructed highlighting the efficiency, equity and capability effects of various policies. Each policy has been rated on a subjective basis. The following point is emphasized: these ratings involve personal judgement and it may be possible in some instances to collapse a complex set of considerations into a simplistic evaluaton of likely effectiveness.[53] While there may be differences of opinion on 'ratings', address of the issues should be instructive to policy-makers The value of the rating exercise is in the

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[53] Such analysis based on value judgement is common in potential evaluation of natural resource policies. See for example Baumol and Oates (1979), Bromley (1978) and Seitz et al. (1978).

TABLE VIII.1

POTENTIAL PERFORMANCE OF ALTERNATIVE POLICIES BY SPECIFIED EFFICIENCY CRITERIA

Policies	Economic Impacts on		Soil Loss Reduction Capability	Administrative Cost
	Farm Operator's Surplus	Consumer's Surplus		
1. Education	Positive +	Positive +	Low/High	Low
2. Research	Positive +	Positive +	Low/High	High
3. Cost-sharing	Positive	Positive	High	High
4. Soil Erosion Control Plan	Positive	Positive	Low/High	Very High
5. Revision of the Soil Conservation Act	Positive	Positive	High	Very Low

+ Conditional

TABLE VIII.2

POTENTIAL PERFORMANCE OF ALTERNATIVE POLICIES BY SPECIFIED EQUITY CRITERIA

Policies	Equality Between			Earned Reward		Least Risk		Freedom and Security
	Farmers	Farmers and Consumers	Present and Future Farmers	Farmer	Consumer	Present Generation	Future Generation	
1. Education	Favorable +	Favorable +	Favorable +	Good	Good	?	?	?
2. Research	Favorable +	Favorable +	Favorable +	Good	Good	?	?	?
3. Cost-sharing	Favorable	Favorable	Favorable	Good	Good	Fair	Fair	Effective
4. Soil Erosion Control Plan	Favorable	Favorable	Favorable	Good	Good	Fair	Fair	Effective
5. Revision of the Soil Conservation Act	Favorable	Favorable	Favorable	Good	Good	Fair	Fair	Effective

+ Conditional
? Undetermined

TABLE VIII.3

POTENTIAL PERFORMANCE OF ALTERNATIVE
POLICIES BY SPECIFIED CAPABILITY CRITERIA

Policies	Farmer	Acceptability				Adaptability to current Infrastructure		Incentives for Improved Performance
		Extension Workers	Legal	Political	Social	Farm	Agencies	
1. Education	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Fair	Good
2. Research	Good	Good	Good	Fair	Good	Good	Good	Good
3. Cost-sharing	Excellent	Excellent	Good	Fair	Excellent	Excellent	Good	Excellent
4. Soil Erosion Control Plan	Good	Excellent	Fair	Excellent	Good	Good	Good	Good
5. Revision of the Soil Conservation Act	Fair	Excellent	Exclient	Excellent	Good	Excellent	Good	Good

demonstration of potential accomplishments resulting from the analysis of efficiency and equity issues inherent in the potential policy alternatives. Although Tables 8.1, 8.2 and 8.3 are self-explanatory, there may be merit in a brief summary which highlights the conclusions in a manner conducive to useful resource policy formulation and assessment.

E.2.1. *Efficiency of Policy Alternatives*

Efficiency criteria indicate the relative efficiency of proposed policies in terms of resultant economic impact on farm operators' surplus, consumers' surplus, soil loss capability, and administrative or institutional or transaction cost (Table VIII.1). For example, education policy is a voluntary program and represented a positive approach, hence, its acceptance rate is high. If adopted by farmers, the results of demonstration projects and other programs related to comparative advantages of continuous cropping and other practices may have positive impacts on farmers' incomes and, consequently, on consumers' surpluses. However, the impact of education policy depends on its diffusion. Control instruments (demonstrations, publications, etc.) of education policy require institutional functions (training of technicians, formulation of programs, etc.) and monitoring functions (implementation). Administrative or institutional costs are involved. Since current organizations can perform these administrative tasks, costs would be low. Similarly, research policy has a positive economic impact on farm operator income and consumers' surplus if the diffusion of research findings reaches the various agents of society effectively. Economic impacts of this policy are conditional for reasons similar to those of education. Research policy may also involve institutional expenditures for conducting research activities and publishing research material. A cost-sharing policy seems to have a positive economic impact on both producers and consumers. This impact may be due to financial incentives to farm operators and to expected public gains from society's investment in soil resources. A cost-sharing policy also involves high institutional costs in terms of maintenance of offices, analysis of farm needs, notification of legislation and other administrative costs. In the case of required development and implementation of a soil erosion control plan policy, economic impacts would be positive. Although this policy rests on mutual implementation, it can be mandatory if mutual implementation fails. Administrative costs of this policy would be very high as it demands considerable extension personnel time and expansion of organization set up. The economic impact of The Soil Conservation Act, if revised and enforced effectively, will have a positive impact. Institutional or administrative costs would be very low in revising this policy document.

E.2.2. *Equitability of Policy Alternatives*

Table VIII.2 presents the performance of proposed policies using equity criteria. To judge the extent to which the proposed policies reduce income differences among farmers, between farmers and consumers and between present and future farmers as a result of soil erosion control, equality criteria are used. Education and research policies are assumed to educate both farmers and consumers and to improve their understanding about soil loss implications. As a result, farmers improve their operations and consumers, as taxpayers, pay less than before for agricultural products. Both receive positive impacts on their incomes. Thus, education and research policy may have favorable impacts in reducing the income gap, depending on methods and approaches involved in education and diffusion of research results. Cost-sharing and soil erosion control plan policies would minimize income differences due to shared responsibilities of producer and consumer for soil resource investment. Act revisions would be favorable for each agent of the society.

Conformity to the earned rewards criterion requires a strict positive correlation between costs and benefits. Since the costs of soil erosion control measures are borne by farmers in part and by consumers in part, all listed policies will tend to have a favorable impact on farms with low soil loss. As a result, consumers may enjoy lower food prices and improved environmental quality.

Least risk criterion implies that a favorable rating will be received by those policies that encourage the use of preventative soil erosion measures and are effective in conserving soil resources for present as well as future generations. In analyzing this criterion from a soil productivity maintenance perspective, it is assumed that farmers will evaluate the policies in terms of a responsibility to maintain soil productivity for future generations. However, they would also consider how much of the cost of so doing should be borne by society. Based on least risk criteria, education and research are rated as indeterminant because they do not provide definite answers to the maintenance of soil productivity. Cost-sharing and soil erosion control planning may be rated as fair in maintaining the soil resource base because incentives are provided and implementation can be effective. The revised Act is a regulatory policy and, hence, will be rated as a fair policy.

The criterion of freedom and security implies restriction or limits on the rights to action by present landowners in order to bring greater consistency between society's expectations and individual behaviour. Cost-sharing, soil erosion control planning and the revised Soil Conservation Act would effectively limit the rights of farm operators. Education and research activities may or may not be effective in limiting farm operators' rights.

E.2.3. *Capability of Policy Alternatives*

The capability criteria indicate the degree of acceptability, adoptability and incentives for improved performance of the proposed policies. Ratings on acceptability by farmers and extension workers is based on survey results (see Chapter VII). All of the proposed policies would probably have fair acceptability legally, politically and socially. There probably would be no poor rating on the adoptability of proposed policies to the current infrastructure. A cost-sharing policy is probably the best policy to improve performance. The other policies may also have good ratings (Table VIII.3).

The efficiency, equity and capability criteria presented here are meant as guidelines for potential performance analysis of soil erosion control policies. Since the criteria were generated subjectively, there is no logical basis for assigning weights to criteria and, hence, general conclusions are not possible. If one analyzes these ratings, it becomes obvious that the policies could be improved somewhat before they are recommended to policy-makers. A range of exogenous changes that may have significant impacts in the long-run in altering the importance of the proposed policies can be offered to policy-makers. The above suggested means of dealing with criteria are superior to the approaches in conventional economics in the sense that these criteria provide more comprehensive formulations for more complex and interdependent situations.

The purpose of this chapter was to use Commons' institutional-mainstream synthesis approach to derive improved theoretical formulations, and to attain a better understanding and conceptualization of the several categories of interdependencies and human interactions with respect to soil resource use. In other words, the purpose was to supplement the neoclassical framework rather than attempt to replace it.

The main thrust of our approach was to focus our attention on farmer behaviour in relation to the use of soil resources in a complex and interdependent situation. Institutional arrangements which define human interrelationships directly affect the behaviour of man. The need for an identification of alternative institutional arrangements to alter behaviour and, consequently, improved performance should be clear. This process requires analysis of current performance, identification of policy alternatives, identification of potential performance indicators of alternatives, assessment of long-run and short-run impacts and assessment of policy performance. These aspects of the process are the linkages that are followed in using the approach outlined herein for soil erosion problems.

The institutional arrangments suggested in this study have the capability of generating relevant information with respect to performance, have the adoptability over time to accomodate changing situations and have the ability to reconcile conflicts of interest in interdependent situations. The suggested institutional arrangements are also flexible in nature and are strongly related to expectations. In other words, farmers' decisions made now are based upon what society expects the institutional arrangements to be in future. However, the adoptive properties of an institutional arrangement will depend to a large extent upon the ability of policy-makers to foresee and prepare for the future. The suggested approach provides, in many ways, a broader description of the problem to the policy-makers.

The creative synthesis of Commons' institutional-mainstream economics utilized in this research provides an alternative analytical formulation in which the major theoretical framework comes from Commons' institutionalism. It also suggests possibilities for analyzing major problems of natural resources that are increasingly complex. The approach to policy suggested herein can be used in natural resources and environmental problems, as well as other problem areas.

IX. Summary, Conclusions and Implications

The main focus of this study is centered on socioeconomic and environmental consequences and policy implications of the soil erosion problem within the context of an interdependent network which emphasizes human interacation with respect to soil resource use. The development and selection of potential alternative soil erosion control policies and organizational structure for soil erosion control, with special reference to the Peace River region of Alberta, is emphasized.

Soil losses from water induced erosion in the region are attributed to soil characteristics, farming practices, farmers' perceptions of current soil uses, and existing soil erosion control policies. The farm level damages associated with soil erosion include loss of productive soil, crop productivity, as well as temporal and spatial damages. Temporal and spatial damages arise because the soil has both qualitative and quantitative characteristics.

Documentation is presented for the fact that the loss of productive scarce soil in the region is the result of static and self-interest behaviour of farm operators who enjoy the liberty of private landownership and ignore society's interests. It is further shown that self-interest behaviour, coupled with private landownership, creates conflict and disorder among farm operators, among farm operators and non-operators and between present and future generations. Alternative institutional arrangements or modifications of existing institutional arrangements may be used to resolve farm level soil loss problems and produce institutionalized individuals and regularities in behaviour. The control issue then becomes one of determining a set of institutional arrangements which influence individual farmer behaviour as well as government agency behaviour. Regularities in economic behaviour or transactions are a function of security, equality, rights, liberty, power, scarcity, efficiency, custom and sovereignty. Since these concepts are the province of Commons' institutional economics and are but obstructions in neoclassical economics, an approach is developed in this study in which the major framework comes from Commons' institutionalism. The structure-conduct-performance model of mainstream economics is supplemented with Commons' institutionalism. The resulting framework (institutional approach) provides a superior and distinguishable alternative formulation in economics. An insitutional approach is then used to evaluate the current existing policies and programs of soil erosion control and to provide a set of alternative institutional arrangements.

The soil resource is viewed as a consumption activity (single input) into a process of soil formation in which soil characteristics (topsoil depth and organic matter) are output (or products). There are many other soil characteristics associated with plant nutrient levels and soil chemistry, but loss of topsoil (a representative quantitative characteristic) and changes in organic matter (a representative qualitative characteristic) are more directly affected by soil erosion in the Peace River region. Soil erosion processes are viewed as involving the removal of undifferentiated particles from farms on the earth's surface and methods which attempt to quantify erosion in terms of soil loss in tonnes per hectare per year are criticized. The Universal Soil Loss Equation and soil damage functions fail to provide an understanding of the complexity of soil characteristics. Only quantitative changes in soil resource use are taken into account. Any attempt to use the Universal Soil Loss Equation in a Canadian context would significantly underestimate the soil loss. Further, the long-run objective of soil erosion prevention would be jeopardized. An alternative formulation using Lancaster's "Goods and Characteristics" approach is suggested to analyze soil characteristics. In order to examine farmers' behaviour and its effects on soil characteristics, Lancaster's new approach to consumer theory is combined with an institutional approach. This synthesis provides a soil characteristics-farmer behaviour model. Using two soil characteristics, organic matter and topsoil depth, along with financial incentives, technical assistance and education as institutional arrangements, two important results are obtained from this model. First, soil characteristics can be improved over time slowly through proper incentives and technical assistance. Second, this model provides both a quantitative and a qualitative analysis of the soil resource which is necessary for soil erosion control policies.

To analyze farmers' perceptions of soil erosion problems and to obtain indications of the perceived acceptability of alterntive soil erosion control policies, a farmer attitude survey was conducted. Responses to alternative policies by regional extension workers were also extracted from information gathered through informal interviews in which their perceptions about various policy issues were revealed. Results of the attitude survey indicate that a majority of farm operators perceive the problem as serious and that sheet and rill erosion are of particular concern to a large proportion of farmers. In farmers' opinions, the most damaging factors contributing to soil erosion problems are soil type, long gentle slopes, spring runoff/snowmelt and drainage disruption due to road contruction. On summerfallowing practices, farmers' views are mixed. This suggests a need for further research on the use of summerfallowing. A majority of farmers clearly perceive declines in yields due to erosion problems and indicate that soil erosion control is needed to maintain soil productivity. This study also suggests that in farmers' views, current soil erosion control policies are ineffective, expensive and time-consuming and do not directly deal with farm level problems. The survey results indicate that most proposed policies are perceived by farmers as "fair". However, farmers favoured mutual or voluntary means of proposed policy implementation.The proposed policies are also perceived by extension workers as fair, effective and adoptable.

An institutional approach developed in this study is used to analyze the effectiveness of current soil erosion policies and government agencies responsible for controlling of soil erosion. The results indicate that the existing institutional network does not provide a wide range of opportunities to alter farm operator behaviour. Courses of action available currently are often unable to facilitate correction of external soil erosion effects for which they were formulated. Existing policies and programs available to farm operators and government agencies generally ignore farm level soil erosion problems which are closely related to farming practices and farmers' perception of soil use. A lack of coordination between government agencies and poor communication with farm operators is observed. This results in aggravated confusion and a high frequency of inaction regarding soil erosion control. Analysis in this study suggests that existing policies are not capable of bringing about at least some degree of correspondence among actions of farm operators, government agencies and the interests of the society.

Keeping in view the root causes of soil loss and resultant private and social costs, a wide range of potential farm level soil erosion control policies are considered. Five policies, education, research, cost-sharing, development and implementation of an approved soil erosion control plan and revision of the Soil Conservation Act are proposed to induce changes in farm operations (conduct), so as to achieve desired performance (maintenance of qualitative and quantitative soil characteristics). A well defined organizational setup which can integrate administrative, financial and research activities is proposed in order obtain full potentialities of the proposed policies. The proposed organizational setup is superior to the existing organization in the sense that it characterizes the organized institutions. The potential performance of the proposed policies is assessed using efficiency, equity and capability criteria. Although the conventional criteria (efficiency and equity) are used, a value judgement, together with Commons' ethical values concept, are also used to broaden the scope of the criteria. Each policy is rated on a subjective basis using efficiency, equity and capability criteria. The value of the rate of exercise is in the demonstration of potential accomplishments resulting from the analysis of efficiency and equity issues inherent in the potential policy alternatives. Although there is no logical basis for analyzing weights for criteria and, hence, no general conclusions are possible, it is possible to determine the potential performance of the proposed policies on various groups of society under several criteria. In general, the proposed policies are consistently equitable, effective and capable regarding various groups of society. It is safe to emphasize that proposed policies would be able to bring some degree of consistency between the action of farm operators, government agencies and the interest of society.

This study has two important policy implications. First, the theoretical significance of the developed approach, and second, the applicability of the suggested approach to other natural resource problems similar to soil erosion problems. The creative synthesis of Commons' institutional-mainstream economics utilized in this research provides an alternative formulation in economics. The major theoretical framework comes from Commons' institutional and legal theories in this approach. Commons' theoretical structure has a treasure of "profound insights" and can not only supplement neoclassical economics, but can make it a complete discipline as is evident from the present analysis. Neoclassical economics is too abstract when used alone to deal with the problems involving several categories of interdependencies and human interactions with respect to natural resource use.

Secondly, the approach used in this study suggests possibilities for analyzing major resource and environmental problems, as well as other problems that are increasingly complex. The suggested approach provides, in many ways, a broader description of the problem to policy-makers and an improved capability to assess public policy preferences.

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Appendix I

INTERVIEW SCHEDULE

No_____ Date___________

1. Name and address of the farmer:

   Name:____

   Address:____

   ____

   ____

2. Do you farm full time? Yes ____ No ____

   (a) If No, what is the nature of off-farm work?

   ____

   ____

   (b) How much time is spent in off-farm work?

   ____

3. Farm organization (in Hectares):

   (i) Sole ownership _____
   (ii) Family ownership _____
   (iii) Partnership with family members _____
   (iv) Partnership with non-family members _____
   (v) Family cooperation _____
   (vi) Non-family cooperation _____
   (vii) An institution or community pasture _____

4. Land Utilization

   (a) Area owned (hectares)
      (i) cultivated _____
      (ii) improved pasture _____
      (iii) unimproved pasture _____
      (iv) bush _____
      (v) building area _____
      TOTAL _____

   (b) Area leased (hectares)
      (i) cultivated _____
      (ii) improved pasture _____
      (iii) unimproved pasture _____
      (iv) bush _____
      (v) building area _____
      TOTAL _____

5. Cultivated Land

(i) What rotation was used in past?

____

____

(ii) Are you planning to alter rotation? Yes ____ No ____

(iii) If yes, what rotation planned?

____

____

6. Area and Crops

Crops		1978	1979	1980	1981 (expected)
Wheat	I				
	F				
	S				
Barley	I				
	F				
	S				
Rape	I				
	F				
	S				
Oats	I				
	F				
	S				
Grass Seed	I				
	F				
	S				
Hay					
Improved Pasture					
Summer-fallow					
Other					

I = Irrigated Area F = Fertilized area S = Sprayed Area

7. Agricultural Machinery and Equipment

Tractor(s)	make	model	year	H.P.	2WD	4WD
1						
2						
3						
4						

Combine(s)	make	model	year	Drum size	self-prop	pull type
1						
2						
3						

Seeders	make	model	year	No. of Boxes	Type	Width
1						
2						

Tillage Equipment	make	model	year	size	Type
Plows					
Cultivators					
Deep tillage					
Light					

Harrowers
1
2

Sprayers	make	model	year	type	tank cap.	Width
1						
2						

8. Livestock

	Number
Cattle	
Dairy cows	______
Beef cows	______
Calves	______
Feeders	______
Steers	______
Pigs	______
Chickens	______
Other	______

9. Do you keep your cattle on community pasture? Yes ____ No ____
Or on your own farm? Yes ____ No ____

10. Do you use the animal waste as manure on your farm? Yes ___ No ___

11. Land value per acre: $ ____________

12. How long had you farmed at this farm? ____________________________

13. Do you periodically check your farm for erosion? Yes ____ No ____
If yes, how often? ____________

14. Do you have erosion problems on your farm? Yes ____ No ____
If yes, describe the magnitude and extent of erosion.

____

____

____

15. What are the factors affecting soil erosion on your farm?

____

____

____

16. Do you perceive a decline in yield due to soil erosion on your farm?
Yes ____ No ____

17. What measures do you take to correct or prevent soil erosion?

____

____

____

18. Even if you don't have a soil erosion problem on your farm, do you perceive the existence of soil erosion in this area?
Yes ____ No ____

19. What tillage practices do you follow for purposes of conservation?

____

____

____

20. What conservation practices do you follow?
    (i) up and down cultivation ____
    (ii) contouring ____
    (iii) contouring and terracing ____
    (iv) cross cultivation ____

21. What combination of tillage and conservation practices do you follow?

____

____

22. Do you practice summerfallowing? Yes ____ No ____

23. Is it an erosion promoting practice in your opinion?

Yes ____ No ____ Don't know ____

24. Do you practice stubble burning? Yes ____ No ____

25. Is it an erosion promoting practice in your opinion?

Yes ____ No ____ Don't know ____

26. Are you satisfied with your current crop production? Yes ___ No ___

27. How effective do you think the following conservation practices are on your farm?

	Effective	Not Effective	Don't Know
1. Deep tillage	____	____	____
2. Discing tillage	____	____	____
3. Minimum tillage	____	____	____
4. Contouring	____	____	____
5. Cross cultivation	____	____	____
6. Up and down cultivation	____	____	____
7. Stubble management	____	____	____
8. Grassed waterways	____	____	____
9. Fall cultivation	____	____	____
10. Continuous cropping	____	____	____
11. Crop rotation with grass	____	____	____

28. Did you notice any economic gain due to good conservation tillage and practices in the following efficiency indicators:

	Lower	Same	Higher
1. Change in crop yields	___	___	___
2. Change in operating expenses	___	___	___
3. Change in soil productivity	___	___	___
4. Time and labour saving	___	___	___
5. Risk of crop failure	___	___	___
6. Problem with respect to:			
(a) weeds, insects and diseases	___	___	___
(b) planting, fertilizer and pesticide use	___	___	___
(c) germination	___	___	___
(d) need for additional equipment	___	___	___

29. Do you think farm level control is needed to maintain long run soil productivity?

Yes ____ No ____ Don't Know ____

30. Do you have access to technical information on the seriousness of erosion problems?

Yes ____ No ____ Don't Know ____

31. Is technical assistance available for crop management and water management effective?

Yes ____ No ____ Don't Know ____

32. Are you aware of various legislative acts of soil erosion control?

Yes ____ No ____ Don't Know ____

33. Do you think government regulations are effective?

Yes ____ No ____ Don't Know ____

34. Do you think cost-sharing arrangements for water management and grass waterways are effective?

Yes ____ No ____ Don't Know ____

35. Do you have any drainage problems on your farm? Yes ____ No ____

If yes, is it due to:

(i) your neighbours ____
(ii) municipalities ditches ____
(iii) road construction ____
(iv) your own farm topography ____
(v) other ____

36. If drainage problems are due to your neighbour, municipalities or roads, do you complain?

Yes ____ No ____

If yes, what kind of response do you get? Explain.

____
____
____
____
____
____

37. If you want to divert water from your field, do you bother to get a permit?

Yes ____ No ____

If no, why not?

____

____

____

____

____

____

38. Do you think that the government regulations are effective?

Yes ____ No ____

If no, what improvements would you like to see?

____

____

____

____

____

____

39. How fair do you think the following policies would be if they were adopted?

	Fair	Unfair	Don't Know
1. Education program	___	___	___
2. Change in crop rotation	___	___	___
3. Required development and implementation of approved soil erosion control plan.	___	___	___
4. Economic incentives for soil erosion control practices:			
(a) cost-sharing (60:40)	___	___	___
(b) tax relief	___	___	___
(c) low interest rate loans	___	___	___
5. Voluntary implementation of policies	___	___	___
6. Mutual implementation	___	___	___
7. Mandatory implementation	___	___	___

Appendix II

1962

CHAPTER 84

An Act respecting Soil Conservation

(Assented to April 5, 1962)

HER MAJESTY, by and with the advice and consent of the Legislative Assembly of the Province of Alberta, enacts as follows:

Short title

1. This Act may be cited as *"The Soil Conservation Act"*.

Interpretation

2. In this Act,

(*a*) "appeal committee" means the persons designated under section 8; — "appeal committee"

(*b*) "Board" means an Agricultural Service Board constituted under *The Agricultural Service Board Act*; — "Board"

(*c*) "council" means the council of a city, town, village, county or municipal district and in the case of an improvement district or special area, the Minister of Municipal Affairs; — "council"

(*d*) "Minister" means the Minister of Agriculture; — "Minister"

(*e*) "municipality" means a city, town, village, county, municipal district, improvement district or special area; — "municipality"

(*f*) "officer" means a soil conservation officer appointed under section 3. — "officer"

Officers

3. (1) Every council shall appoint such soil conservation officers as are required for the proper administration of this Act within its municipal boundaries.

(2) The powers and duties conferred upon an officer by this Act may only be exercised within the municipality for which he is appointed.

(3) The Minister may appoint such officers within a municipality as he considers necessary and may prescribe their duties and determine their remuneration.

(4) The salaries and expenses of an officer appointed by the Minister pursuant to subsection (3)

(*a*) shall be paid by the municipality to the Minister upon demand, and

(*b*) are recoverable by the Minister as a debt due to the Crown.

Duty of landholder

4. Every person who owns, occupies or controls land

(*a*) shall take active measures to prevent soil deterioration upon the land by the action of wind or water or by any other cause, and

(*b*) shall obey any notice given pursuant to this Act.

Notices

5. (1) Where an officer is satisfied that any practices that are being followed with respect to land are causing or are likely to cause soil deterioration, he shall serve upon the person who owns, occupies or controls the land a notice directing such person to take such action to prevent soil deterioration on the land as may be specified in the notice.

(2) A notice under subsection (1) shall state the maximum time within which the recommended soil conservation practice is to be carried out by the person to whom the notice is addressed.

(3) A notice under subsection (1) shall be served by

(*a*) personal service,

(*b*) double registered mail addressed to the person to be served at his last known address and such service shall be deemed to be served two days after such double registered letter is posted, or

(*c*) by personal service upon any adult member of the same household where the person to whom the notice is addressed resides.

(4) The officer shall serve a copy of any notice given under subsection (1) on the council of the municipality.

Report to Agricultural Service Board

6. (1) Where in the opinion of an officer in a municipality for which a Board has been appointed, farm land in the municipality

(*a*) is impoverished or in the process of becoming impoverished through

(i) wind or water erosion, or

(ii) any other cause that has seriously affected or may seriously affect the productivity of the land or the welfare of the owner or occupant of the land,

and

(*b*) may become a menace to the community,

the officer shall report his findings to the Board who after investigation and inquiry shall report its findings and recommendations to the council.

(2) Upon receipt of the report under subsection (1), the council may declare the land referred to in the report to be subject to supervision, rehabilitation or reclamation as set out in *The Agricultural Service Board Act*.

Appeal

7. (1) Any person

(*a*) who owns, occupies or controls land affected by a notice given by an officer pursuant to this Act, and (*b*) who is aggrieved by the notice,

may appeal therefrom to the appeal committee of the municipality within the time fixed by the order of the officer for carrying out the recommended soil conservation practice and not afterward.

(2) An appeal shall be commenced by the delivery, within the time limited by subsection (1), of a notice of appeal, which shall be in writing and shall set out

(*a*) the name and address of the appellant,

(*b*) a description of the notice appealed from,

(*c*) the location of the land in respect of which the notice was given, and

(*d*) the grounds of the appeal.

(3) The notice of appeal shall be delivered,

(*a*) in the case of a municipality other than an improvement district or special area, to the person for the time being in charge of the office of the secretary or clerk of the municipality, and

(*b*) in the case of an improvement district or special area, to any person employed in the office of the Minister of Municipal Affairs.

(4) In the case of an appeal to the council or to the members of the council of a municipality the appellant shall, before the hearing of the appeal, deposit with the secretary or clerk of the municipality the sum of five dollars which shall be returned to him if the appeal is allowed, but in any other event shall be forfeited to and become the property of the municipality.

8. (1) In a municipal district or county, the appeal committee shall consist of such members of the council, being not less than three in number, or the members of the Agricultural Service Board, as may from time to time be appointed by resolution of the council for that purpose, and in default of either such appointment, the whole council. Appeal committee

(2) In a city, town or village, the appeal committee shall consist of such members of the council, being not less than three in number, as may from time to time be appointed by a resolution of the council for that purpose, and in default of any such appointment, the whole council.

(3) In an improvement district or special area the appeal committee shall consist of not less than three persons who shall be appointed by the Minister of Municipal Affairs.

9. (1) As soon as conveniently possible after the service of the notice of appeal the appeal committee to whom the appeal lies, shall Hearing of appeal

(*a*) fix a place for the hearing of the appeal, which may be on the land affected by the notice,

(*b*) fix a time for the hearing of the appeal, and

(c) cause notice of the place and time to be sent to the appellant.

(2) At the time and place stated the appeal committee shall hear the appeal and may, by order, confirm the notice of the officer or

(a) set aside the notice of the officer,
(b) vary the notice,
(c) extend the time within which any thing required to be done by the notice is to be performed, or
(d) direct any thing to be done that an officer by notice given under this Act can direct to be done either in addition to or in substitution for the directions in the notice appealed from.

Remedial work

10. (1) An officer or a person duly authorized by him may enter upon the land affected and perform the required work

(a) when the notice is not complied with within the time limited by the notice and the notice has not been appealed,
(b) when the notice is not complied with within the time limited by the notice and an appeal has been dismissed, and
(c) when the varied notice or the substituted notice of the appeal committee is not complied with within the time limited by such varied notice or substituted notice.

(2) The expenditures made as a result of the work performed pursuant to subsection (1) shall be paid by the municipality or if the Minister pays for such expenditures, the amount so paid is a debt due from the municipality to the Crown.

(3) The council

(a) may notify the owner or occupier of the land of the amount of the expenditure chargeable against the land, and
(b) may collect the amount of the expenditures from the owner or occupier in the manner set out in sections 277 and 278 of *The Municipal District Act.*

By-laws

11. A council, by by-law, or in the case of an improvement district or special area the Minister of Municipal Affairs, by order, may provide for all or any of the following:

(a) a system of permits controlling the removal of top soil from land;
(b) a system of permits controlling the burning of stubble on land;
(c) the terms and conditions under which a permit may be issued, suspended, reinstated or revoked;
(d) the prohibition of the removal of top soil or the burning of stubble on land.

Penalties

12. A person

(*a*) who fails to comply with a notice served upon him pursuant to this Act,

(*b*) who fails to comply with the condition of a permit granted pursuant to a by-law or order under section 11,

(*c*) who contravenes a provision of a by-law or order under section 11, or

(*d*) who obstructs an officer in any way while the officer is carrying out his duties pursuant to this Act,

is guilty of an offence and is liable on summary conviction to a fine of not less than twenty dollars and not more than two hundred dollars and in default of payment thereof to imprisonment for a term of not more than thirty days.

Entry on lands

13. An officer, the members of a Board, the members of a council, the Minister of Municipal Affairs, the Minister, or any person duly authorized by them may, in carrying out any duties imposed upon them by this Act and generally to carry out the provisions of this Act, enter upon the lands within a municipality at any reasonable time.

Saving rights

14. No action lies against

(*a*) the Minister,

(*b*) the Minister of Municipal Affairs,

(*c*) a municipality or an official of a municipality,

(*d*) a member of a Board, or

(*e*) an officer or other person,

for an act done or performed in good faith and purporting to have been done or performed under the provisions of this Act or the regulations.

Regulations

15. The Lieutenant Governor in Council may make regulations respecting any matter or thing as may be required for the purpose of giving effect to the provisions of this Act.

Construction of Act

16. Nothing in this Act shall be construed as repealing or abrogating sections 12 to 14 of *The Agricultural Service Board Act* or section 23 of *The St. Mary and Milk Rivers Development Act, 1950*.

Repeal

17. *The Soil Drifting Control Act*, being chapter 316 of the Revised Statutes, is hereby repealed.

Coming into force

18. This Act comes into force on the day upon which it is assented to.

SOURCE: L.S. Wall, Printer to the Queen's Most Excellent
Majesty. Edmonton, Alberta: 1964.